



Designing, Building and Coding Custom Raspberry Pi RP2040 Arduino Devices

Day 3: The RP2040, Arduino and BLE

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Fred Eady

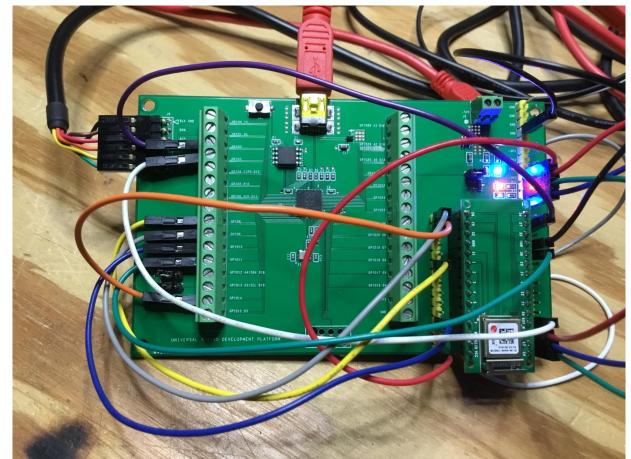
Visit 'Lecturer Profile' in your console for more details.



AGENDA



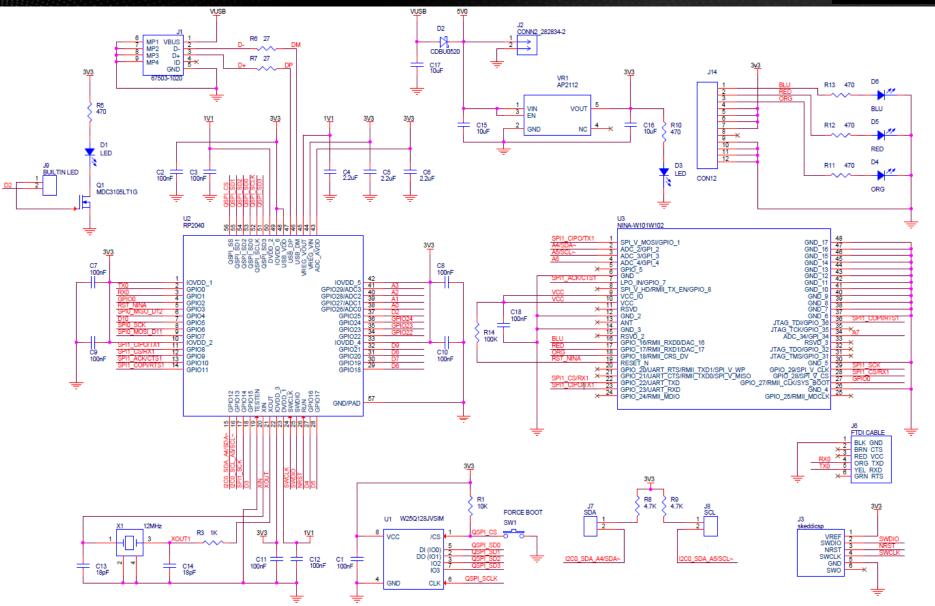
- RP2040 Arduino BLE Hardware
- u-blox Frankenstein
- Arduino BLE On Your Phone





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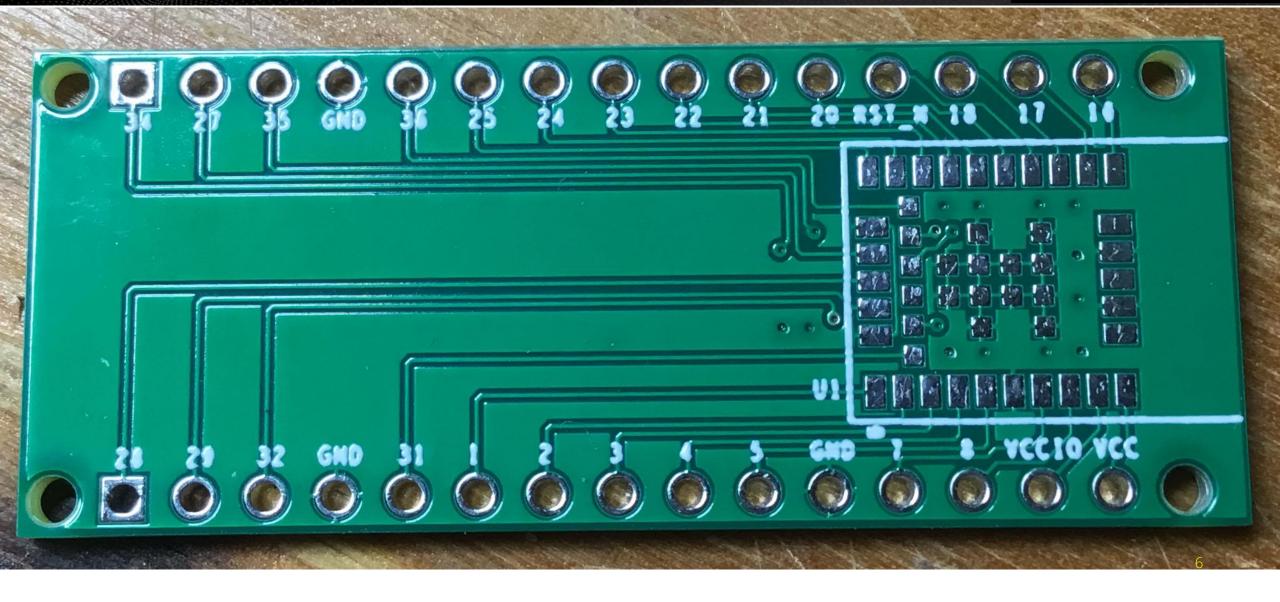
RP2040 Arduino BLE Hardware Design



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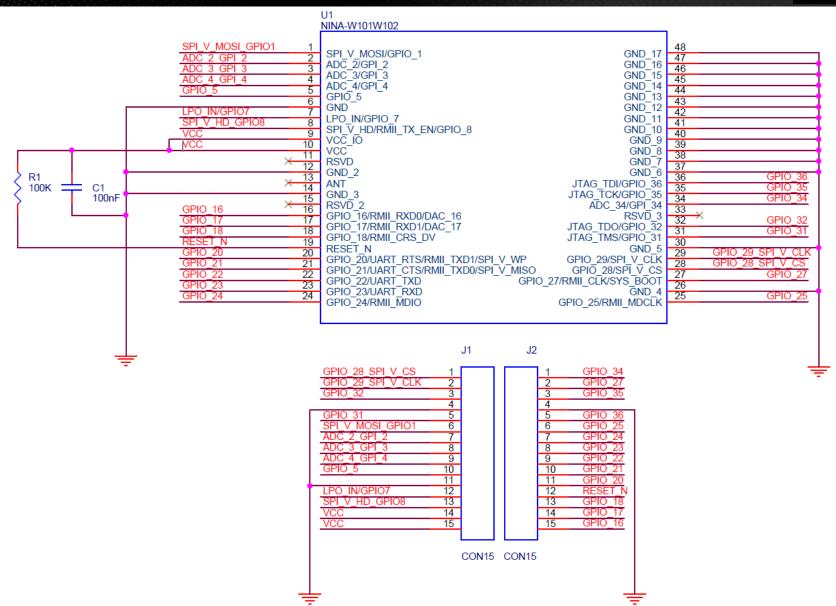


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RP2040 Arduino BLE Hardware



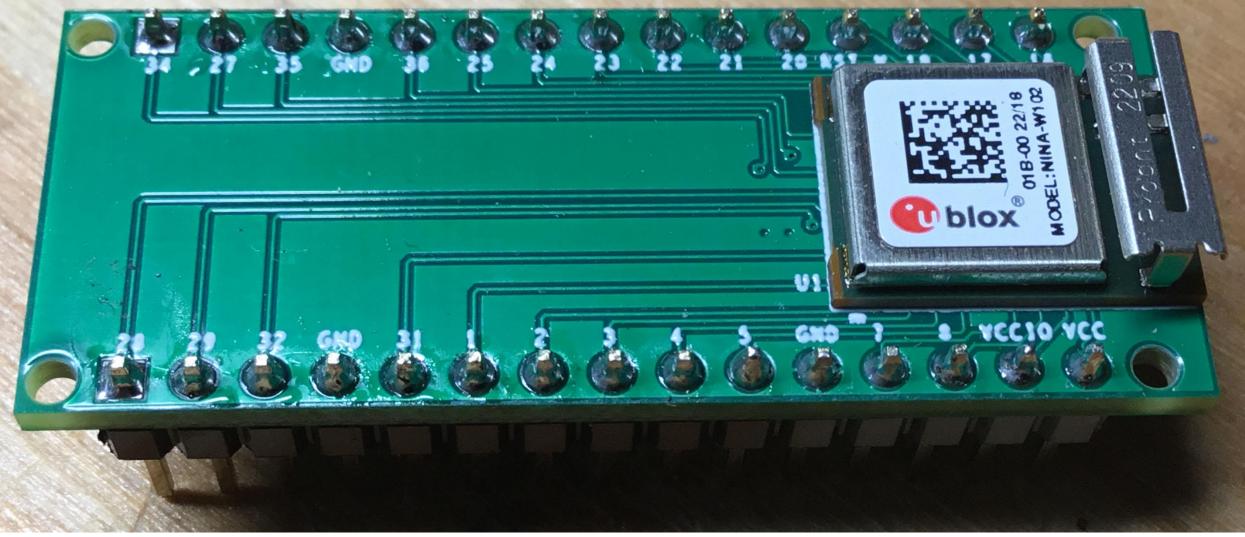
RP2040 Arduino BLE Hardware Design



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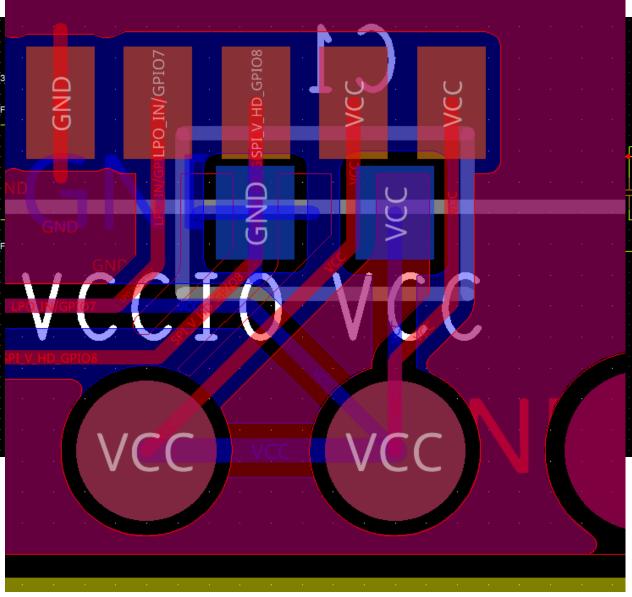


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	· · · · · · · · · · ·	U2 RP2040	55 55 55 55 55 55 55 55 55 55 55 55 55			U3 NINA-W101W102	
31/2	•		COSPI_SS COSPI_SS COSPI_SD COSPI_SD COSPI_SD2	3 <u>V3</u> C8 100nF	A5/SCL~ A6	1 SPI_V_MOSI/GPIO_1 GND_17 2 ADC_2/GPI_2 GND_16 4 ADC_3/GPI_3 GND_16 5 ADC_4/GPI_4 GND_13 6 GPI0_5 GND_13	46 45 44
	TX0 2 RX0 3 GPIO0 RST_NINA 5 SPI0 MISO D12 0	0VDD_1 GP100 GP101 GP102 GP102 GP103	GPI029/ADC3 GPI029/ADC3 GPI028/ADC2 GPI027/ADC1 GPI028/ADC0	42 41 A3 40 A2 39 A1 38 A0 37 D2 C18	SPI1_ACK/CTS1 VCC X VCC 1	7 GND GND_12 8 LPO_IN/GPIO_7 GND_11 9 SPI_V_HD/RMII_TX_EN/GPIO_8 GND_10 10 VCC_IO GND_2 11 VCC GND_2 12 RSVD GND_2	42 41 40 39 38
	D10 SPI0_SCK 3 SPI0_MOSI_D11 5 010 SPI1_CIP0/TX1 1	GP104 GP105 GP106 GP107 IOVDD_2	GPI025 GPI024 GPI022 GPI022 IOVDD_4 GPI021	36 GPI024 100r 35 GPI023 100r 34 GPI022 100r 33 100r 100r	11 11 11 11 11 11 11 11 11 11 11 11 11	Image: Constraint of the state of	35 34 33 33
F .	SPI1_CS/RX1 12 SPI1_ACK/CTS1 13 SPI1_COPI/RTS1 14		GPI020 GPI019 GPI018	31 D8 C10 30 D7 100nF 29 D6	RST_NINA 11 22 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	GPIO_18/RMII_CRS_DV JTAG_TMS/GPIO_31 20 RESET_N GND_6 21 GPIO_20/UART_RTS/RMII_TXD1/SPI_V_WP GPIO_29/SPI_V_CLK 22 GPIO_21/UART_CTS/RMII_TXD0/SPI_V_MISO GPIO_28/SPI_V_CS 23 GPIO_22/UART_TXD GPIO_27/RMII_CLK/SYS_BOOT	30 29 SPI1_SCK 28 SPI1_CS/RX1 27 GPI00 28
			Ded/Dug 23 23 23 23 23 23 23 23 23 23	57	· · · · · · · · · · · · · · · · · · ·	GPIO_23/UART_RXDGPIO_25/RMII_MDCLK	25
			12C0_SDA_A44SDA- 12C0_SCL_A64SCL- 5P11_SCK D3 X1N X0UT X0UT SWCLK SWCLK SWCLK SWCLK SWCLK SWCLA SWCCA SWCLA SWCLA SWCLA SWCCA				



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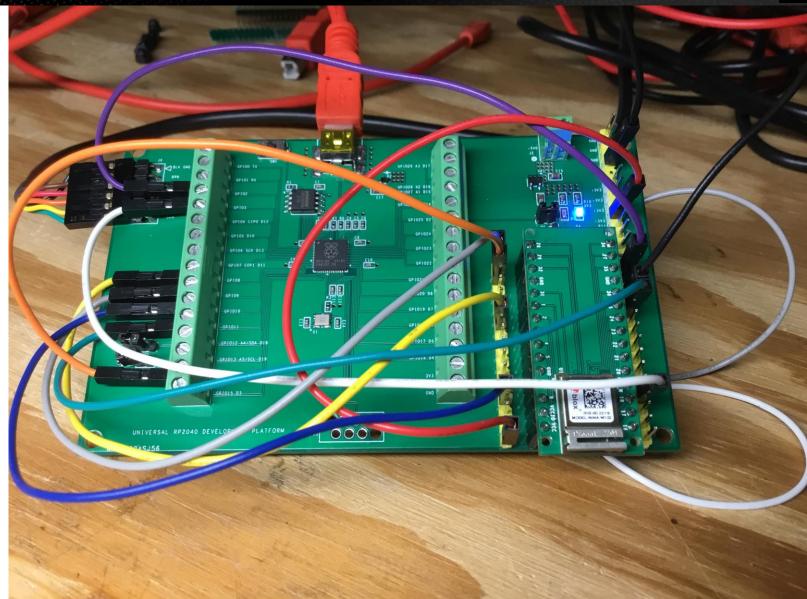


C18 100nF		U3 NINA-W101W102 SPI_V_MOSI/GPIO_1 ADC_2/GPI_2 ADC_3/GPI_3 ADC_3/GPI_3 GND_15 ADC_4/GPI_4 GND_15 GND_14 GPIO_5 GND_17 GND_12 LPO_IN/GPIO_7 SPI_V_HD/RMII_TX_EN/GPIO_8 RSVD GND_10 VCC_10 VCC G GND_8 RSVD GND_7 GND_2 GND_7 GND_2 GND_7 GND_2 GND_7 GND_2 GND_7 GND_7 GND_7 GND_7 GND_7 GND_7 GND_7 GND_7 GND_7 GND_8 RSVD GND_10 JTAG_TDI/GPIO_36 GND_10 JTAG_TCK/GPIO_35 RSVD_2 GPIO_17/RMII_RXD1/DAC_16 GPIO_18/RMII_RXD1/DAC_17 JTAG_TDO/GPIO_32 GPIO_18/RMII_RXD1/DAC_17 JTAG_TDO/GPIO_31 RESET N GND_5	48 47 46 45 44 43 42 41 40 39 38 37 36 SPI1_COPI/RTS1 35 34 A7 33 32 31 30
	SPI1_CS/RX1 22 SPI1_CIPO/TX1 23 24	GPIO_22/UART_TXD GPIO_27/RMII_CLK/SYS_BOOT GPIO_23/UART_RXD GND_4 GPIO_24/RMII_MDIO GPIO_25/RMII_MDCLK	
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RP2040 Arduino BLE Hardware Design





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Load the Arduino BLE and Wi-Fi Libraries

E Arduino Library Manage	er ×		□ ·			
Туре Аш	- Topic All	- BLE				
Only show libraries st	upported by current board					
Refresh Library Index						
ArduinoBLE by Arduino [BETA] Enables BLE connectivity on the Arduino MKR WiFi 1010 and Arduino UNO WiFi Rev.2. This library currently supports creating a BLE peripheral. More info						
1.3.4 - In:	stall					

WiFiNINA by Arduino

Enables network connection (local and Internet) with the Arduino MKR WiFi 1010, Arduino MKR VIDOR 4000 and Arduino UNO WiFi Rev.2. With this library you can instantiate Servers, Clients and send/receive UDP packets through WiFi. The board can connect either to open or encrypted networks (WEP, WPA). The IP address can be assigned statically or through a DHCP. The library can also manage DNS.

More info

1.8.14 Install



🔵 RTS

CTS

\varTheta RXD

DCD

ROCO R4C1

DSR

COM5 8N1 9600

DTR

\varTheta Rina

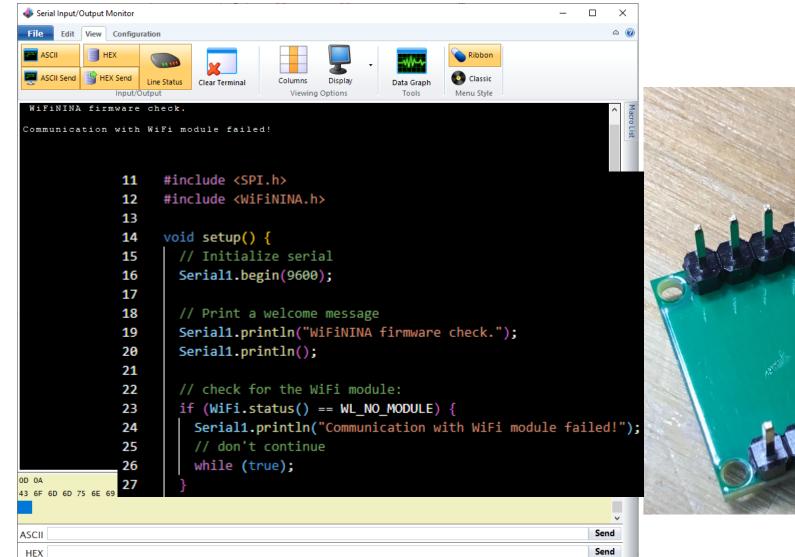
TXD

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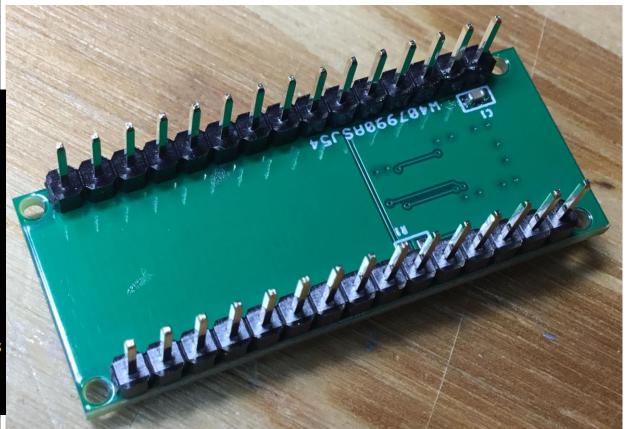
Pins Up - The Monster Is Dead



\varTheta Break

Disconnect

Error





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u-blox Frankenstein

Give Life to the Monster



o TouchTest | Arduino IDE 2.1.1 × _ File Edit Sketch Tools Help Auto Format Ctrl+T √ .O. \rightarrow Archive Sketch TouchTes Manage Libraries... Ctrl+Shift+I narroware SPI porc only: 29 Serial Monitor Ctrl+Shift+M 30 CLOCK spectively 31 Serial Plotter 包 suggest #10 on an Uno 32 WiFi101 / WiFiNINA Firmware Updater MPE610 (there is no reset pin) 34 Upload SSL Root Certificates 510(STMPE CS); 35 36 Board • ₽> *any* 4 I/O pins! 37 Port you want and wire up! 38 Get Board Info MPE610 (there is no reset pin) 39 40 E610(STMPE CS, STMPE SDI, STMPE SDO, STMPE SCK); Burn Bootloader 41 42 43 44 void setup() { Serial.begin(9600); 45 46 Serial.println("Adafruit STMPE610 example"); Serial.flush(); 47 48 // if using hardware SPI on an Uno #10 must be an output, remove line 49 50 // if using software SPI or I2C 51 pinMode(10, OUTPUT); 52 // If using I2C you can select the I2C address (there are two options) by calling 53 // touch.begin(0x41), the default, or touch.begin(0x44) if A0 is tied to 3.3V 54 // If no address is passed, 0x41 is used 55 if (! touch.begin()) { 56 Serial.println("STMPE not found!"); 57 8 58 while(1);

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Give Life to the Monster



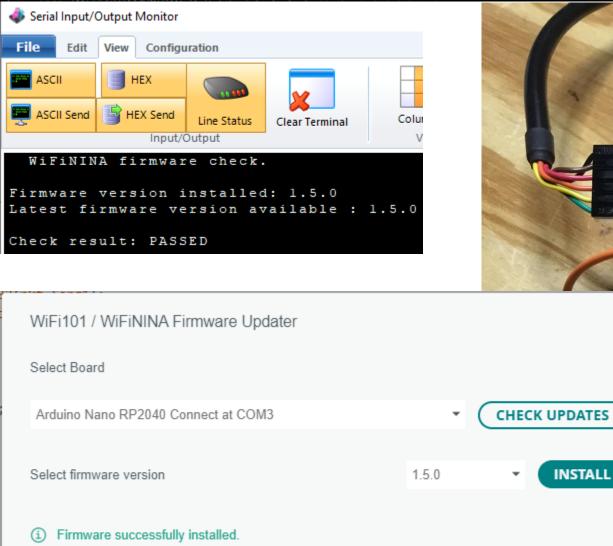
	🔤 ble_peripheral Arduino IDE 2.1.1								
File Ed	File Edit Sketch Tools Help								
		Select Board	•						∿ .©.
P	ble_peripheral.ino								
	1	<pre>#include <arduinoble.h></arduinoble.h></pre>							
	2								
1	3	<pre>int buttonPin = 2;</pre>							
	4	boolean ledSwitch;							
	5								
	6		210000_E8E2_537E_4E6C_D104768A1214") · // RLE LEG) Sorvico					
	7	<pre>// BLE LED Switch Charact BLEByteCharacteristic LEC</pre>	WiFi101 / WiFiNINA Firmware Updater			<			
⇒ ⊕	8	<pre>void setup() {</pre>);			
	10	Serial.begin(9600);	Select Board						
\bigcirc	11	pinMode(buttonPin, INPL	odot bourd						
\sim	12	<pre>// begin initialization</pre>				、 IIII			
	13	<pre>if (!BLE.begin()) {</pre>	Arduino Nano RP2040 Connect at COM3	*	CHECK UPDATES				
	14	Serial.println("start							
	15	}	0.1.10	4.5.0					
	16	<pre>// set advertised local</pre>	Select firmware version	1.5.0	INSTALL				
	17	BLE.setLocalName("Butte		1.5.0					
	18	BLE.setAdvertisedServic	A least-least and will account a the Cluster on the based	1.4.8					
	19	<pre>// add the characteris</pre>	▲ Installation will overwrite the Sketch on the board.	1.4.7					
	20	LEDService.addCharacter		1.4.6					
	21 22	<pre>// add service PLF_addService(LEDService)</pre>		1.4.5					
	22	BLE.addService(LEDServi- // start advertising		1.4.5					
	23	BLE.advertise();							
	25		Peripheral, waiting for connections");						
	26	}							
27 void loop() {									
	28	// listen for BLE periph	nerals to connect:						
	29	BLEDevice central = BLE.							
	30	// if a central is conne	ected to peripheral:				In 1 Col 1 - X		

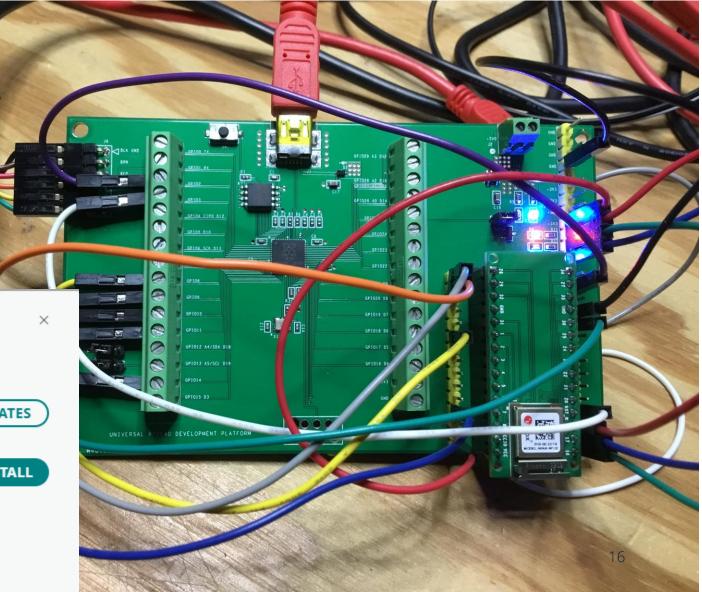


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Give Life to the Monster

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Arduino BLE Setup



		U3 NINA-W101W102		
	SPI1_CIPO/TX1 1 A4/SDA~ 2 A5/SCL~ 3 A6 4	SPI_V_MOSI/GPIO_1 GND_17 ADC_2/GPI_2 GND_16 ADC_3/GPI_3 GND_15 ADC_4/GPI_4 GND_14	45	
· · · · · · · · · · · · ·	6 <u>SPI1_ACK/CTS1</u> 8 VCC 9 VCC 10	GPIO_5 GND_13 GND GND_12 LPO_IN/GPIO_7 GND_11 SPI_V_HD/RMII_TX_EN/GPIO_8 GND_10 VCC_10 GND_9	43 42 41 40 39	
C18 100nF	$\begin{array}{cccc} & 11 \\ & 12 \\ & 13 \\ & 14 \end{array}$	VCC GND_8 RSVD GND_7 GND_2 GND_6 ANT JTAG_TDI/GPIO_36	38 37 36 SPI1_COPI/RTS1 35	
R14 100K	8LU 16 RED 17 ORG 18 RST_NINA 19	GND_3 JTAG_TCK/GPIO_35 RSVD_2 ADC_34/GPI_34 GPIO_16/RMII_RXD0/DAC_16 RSVD_3 GPIO_17/RMII_RXD1/DAC_17 JTAG_TD0/GPIO_32 GPIO_18/RMII_CRS_DV JTAG_TMS/GPIO_31	34 A7 33 32 31 30	···
	20 21 SPI1_CS/RX1 22 SPI1_CIPO/TX1 23 24	RESET_N GND_5 GPIO_20/UART_RTS/RMII_TXD1/SPI_V_WP GPIO_29/SPI_V_CLK GPIO_21/UART_CTS/RMII_TXD0/SPI_V_MISO GPIO_28/SPI_V_CS GPIO_22/UART_TXD GPIO_27/RMII_CLK/SYS_BOOT GPIO_23/UART_RXD GND_4	29 SPI1_SCK 28 SPI1_CS/RX1 27 GPIO0 26 25	8 818 81
	· · · · · · · · · · · · · · · · · · ·	GPIO_24/RMII_MDIO GPIO_25/RMII_MDCLK		
	F			

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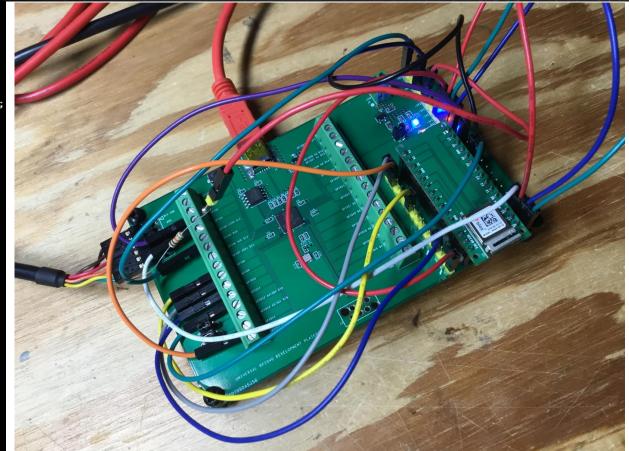
The RP2040, Arduino and BLE

Arduino BLE On Your Phone

Arduino BLE Setup

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#include <ArduinoBLE.h> 21 22 23 24 const int ledPin = LED BUILTIN; // set ledPin to on-board LED (D2 - RP2050 GPI025) const int buttonPin = 10; // set buttonPin to digital pin 10 (D10 - RP2050 GPI05) 25 BLEService ledService("19B10010-E8F2-537E-4F6C-D104768A1214"); // create service 26 // create switch characteristic and allow remote device to read and write 27 BLEByteCharacteristic ledCharacteristic("19B10011-E8F2-537E-4F6C-D104768A1214", BLERead | BLEWrite | BLENotify) 28 // create button characteristic and allow remote device to get notifications 29 BLEByteCharacteristic buttonCharacteristic("19B10012-E8F2-537E-4F6C-D104768A1214", BLERead | BLENotify); 30 31 32 33 34 void setup() { Serial1.begin(9600); while (!Serial1); 35 36 37 38 39 40 41 42 43 44 pinMode(ledPin, OUTPUT); // configure the LED pin as an output pinMode(buttonPin, INPUT); // configure the button pin as an input // BLE initialization if (!BLE.begin()) { Serial1.println("Starting Bluetooth® - Low Energy module failed!"); while (1); // set the local name peripheral advertises 45 46 47 BLE.setLocalName("BTNLED"); // set the UUID for the service this peripheral advertises: BLE.setAdvertisedService(ledService); 48 49 50 51 52 53 54 55 56 57 58 59 60 61 // add the characteristics to the service ledService.addCharacteristic(ledCharacteristic); ledService.addCharacteristic(buttonCharacteristic); // add the service BLE.addService(ledService); ledCharacteristic.writeValue(0); buttonCharacteristic.writeValue(0); // start advertising BLE.advertise(); 62 Serial1.println("Bluetooth® device active, waiting for connections..."); 63



22	// D8 - D13		
23	{ p20,	NULL, NULL, NULL },	// D8
24	{ p21,	NULL, NULL, NULL },	// D9
25	{ p5,	NULL, NULL, NULL },	// D10 buttonPin
26	{ p7,	NULL, NULL, NULL },	// D11 / SPITX 18
27	{ p4,	NULL, NULL, NULL },	
28	{ p6,	NULL, NULL, NULL },	// D13 / SPICLK / LEDB



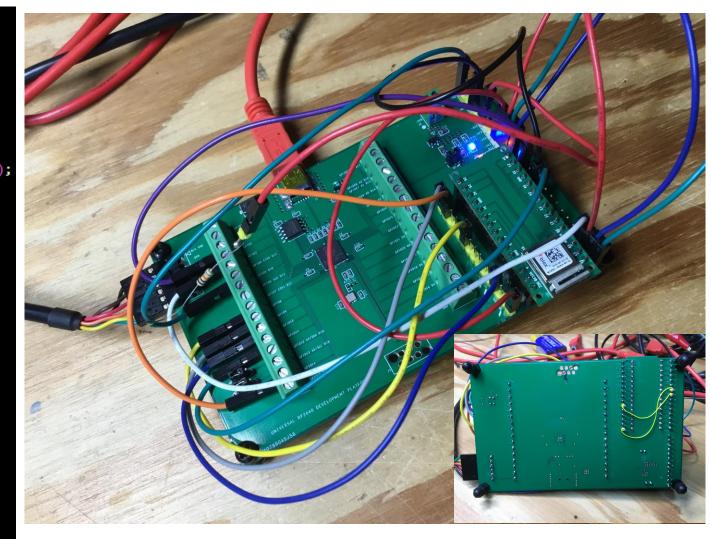
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Arduino BLE Loop

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void loop() { 65 66 // Poll for Bluetooth[®] Low Energy events 67 BLE.poll(); 68 69 // read the current button pin state 70 char buttonValue = digitalRead(buttonPin); 71 72 // has the value changed since the last read bool buttonChanged = (buttonCharacteristic.value() != buttonValue); 73 74 75 if (buttonChanged) { 76 // button state changed, update characteristics 77 ledCharacteristic.writeValue(buttonValue); 78 buttonCharacteristic.writeValue(buttonValue); 79 80 81 if (ledCharacteristic.written() || buttonChanged) { // central has written to characteristic 82 83 // or button state has changed..Update LED 84 if (ledCharacteristic.value()) { 85 Serial1.println("LED on"); 86 digitalWrite(ledPin, HIGH); 87 else { 88 Serial1.println("LED off"); digitalWrite(ledPin, LOW); 89 90 91





Designing, Building and Coding Custom Raspberry Pi RP2040 Arduino Devices

The RP2040, Arduino and BLE

Arduino BLE On Your Phone

Arduino BLE First Contact



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		×	ADVI	ERTISEMENT DAT	ΓA
Punch Through			Connection status Connected		
Eniovir	ng LightBlue®?		Adve BTNLE	rtised name D	
	about our insights into	BLE.		rtised service UUID	
Email /	Address		196100	010-e8f2-537e-4f6c-d1047	6881214
SUBSCR			0x0201	Raw advertisement packet 0x020106110614128A7604D16C4F7E53F2E81000B11 9070942544E4C4544000000000000000000000000000000	
Q		=		000000000000000000000000000000000000000	
-66dBm	[TV] Samsung T	CONNECT ~	DEVI	CE INFORMATION	N
-00UDIII	04:B9:E3:2B:54:17		Devic	e Address	
-39dBm	BTNLED 58:BF:25:0E:E6:2E	CONNECT ~	58:BF:2	25:0E:E6:2E	
A	Unnamed		GENE	ERIC ACCESS	
! -98dBm	56:2D:B4:62:67:CF	CONNECT ~	Devic Readab	e Name	\rightarrow
-63dBm	Unnamed 22:00:CB:E8:ED:D2	CONNECT ~		arance	\rightarrow
4	Unnamed		Readab	ble	
-95dBm	90:DD:5D:EE:34:E3	CONNECT	GEN	ERIC ATTRIBUTE	
Sc		_ Learn	Servi	ce Changed	\rightarrow

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:	← BTNLED	÷
	Num auvertisement paoket	
	0x020106110614128A7604D16C4F7E53F	2E81000B11
	9070942544E4C45440000000000000000	
	000000000000000000000000000000000000000	000000
	DEVICE INFORMATION	
	DEVICE IN ORMATION	
	Dealer Address	
	Device Address	

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58:BF:25:0E:E6:2E

GENERIC ACCESS

Device Name Readable

Appearance Readable

GENERIC ATTRIBUTE

Service Changed Indicate

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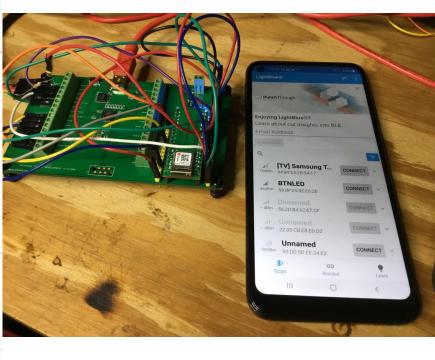
19b10010-e8f2-537e-4f6c-d104768a 1214

19b10011-e8f2-537e-4f6c-d104768a 1214 Readable, Writable, Notify

19b10012-e8f2-537e-4f6c-d104768a 1214 Readable, Notify

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Arduino BLE First Contact

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← BTNLED

Nam auvertisement packet

DEVICE INFORMATION

Device Address 58:BF:25:0E:E6:2E

GENERIC ACCESS

Device Name Readable	\rightarrow
Appearance Readable	\rightarrow

GENERIC ATTRIBUTE

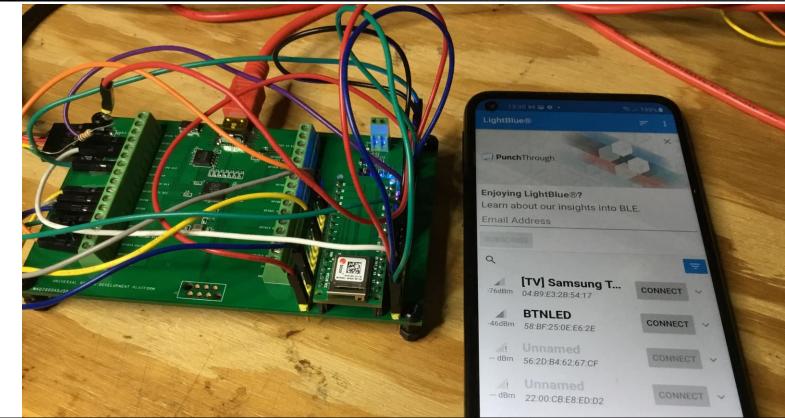
Service Changed

19b10010-e8f2-537e-4f6c-d104768a 1214

19b10011-e8f2-537e-4f6c-d104768a 1214 Readable, Writable, Notify

19b10012-e8f2-537e-4f6c-d104768a 1214 Readable, Notify

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- 25 BLEService ledService("19B10010-E8F2-537E-4F6C-D104768A1214"); // create service
- 26 // create switch characteristic and allow remote device to read and write
- 27 BLEByteCharacteristic ledCharacteristic("19B10011-E8F2-537E-4F6C-D104768A1214", BLERead | BLEWrite | BLENotify);
- 28 // create button characteristic and allow remote device to get notifications

29 BLEByteCharacteristic buttonCharacteristic("19B10012-E8F2-537E-4F6C-D104768A1214", BLERead | BLENotify);

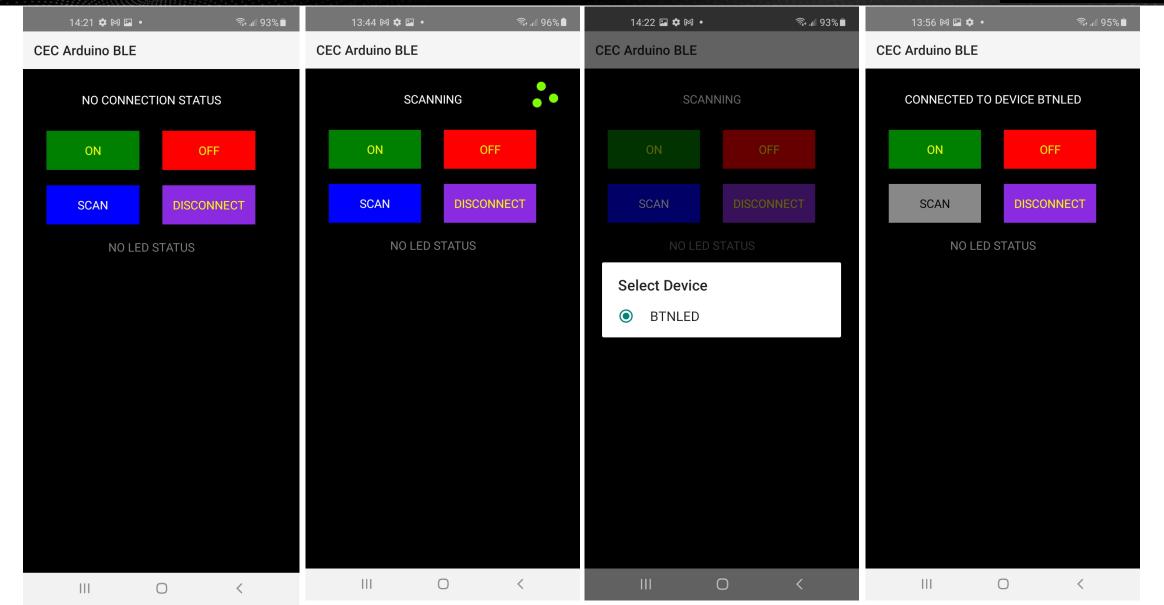




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Arduino BLE On Your Phone

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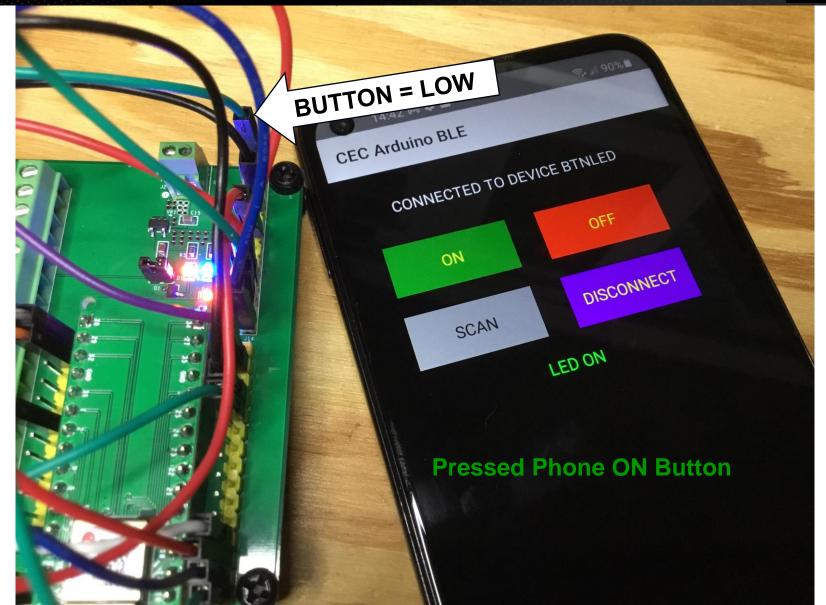
Arduino/B4A BLE Remote Control App



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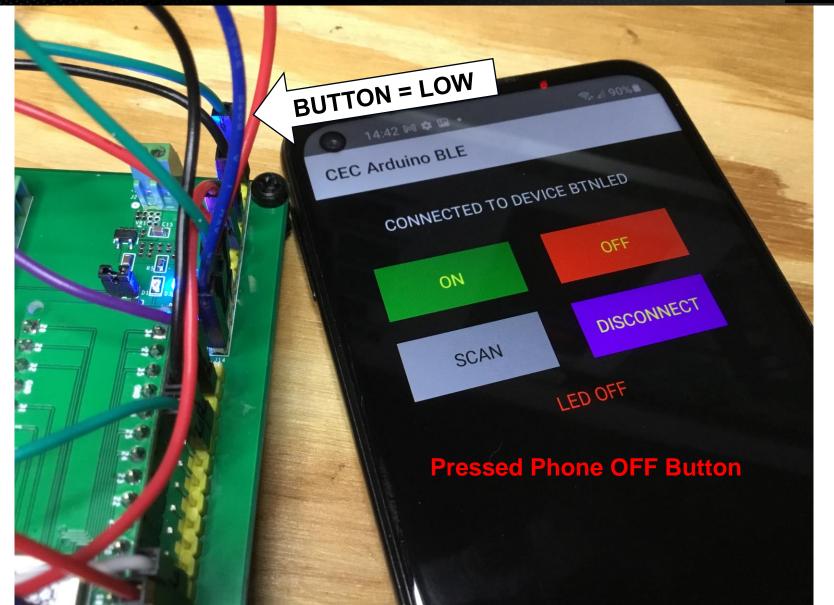


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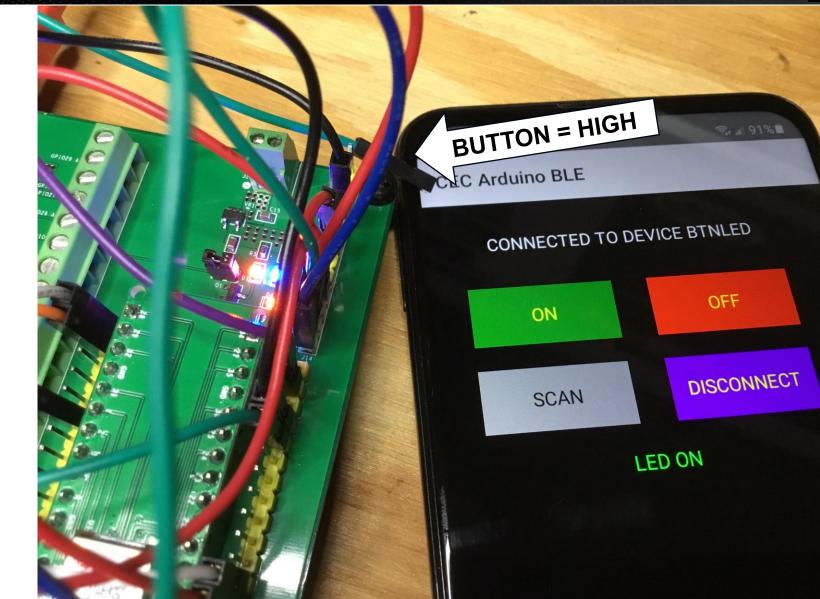


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Thank you for attending!!!

Please consider the resources below:

- arduino.cc
- b4x.com
- raspberrypi.org
- u-blox.com

MORE TO COME..

Second Se	- 🗆 X
UDP Setup Serial TCP Client TCP Server UDP Test Mode About	
Received data UDP socket created NINA ORG LED = ON NINA RED LED = ON NINA BLU LED = ON	UDP Module IP Port 192.168.1.75 8088 Local port 4044 Close Server settings
Sent data NOINRINB1	 Redirect to TCP Server Redirect to TCP Client
	UDP broadcast File name: No file Load file
Send	
N01 □ HEX NB1 □ HEX	Send HW group www.HW-group.com Hercules SETUP utility
NB1 THEX	Send Version 3.2.8





Thank You





SALANA.

