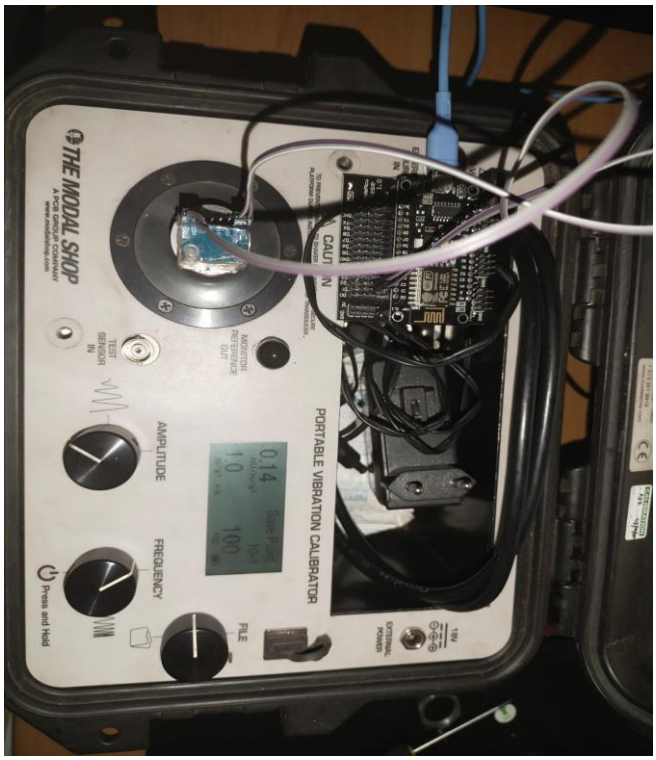
LAMPIRAN

Lampiran 1

Rancangan Rangkaian Perangkat Keras

Lampiran 2

Proses Uji karakteristik Alat Ukur



Lampiran 3

Proses Pengambilan Data Vibrasi *Induced Draft Fan*

Suhu pada biring motor induced draft fan

Lampiran 4

Program Arduino IDE

```
#include <ESP8266WiFi.h> //library esp8266
#include <WiFiUdp.h> //library protokol udp
#include <Wire.h> //library untuk komunikasi serial sinkron
dengan dua kabel yakni SDA (Serial Data) dan SCL (Serial
Clock).
#include <ADXL345.h> // library untuk sensor ADXL345

#ifndef STASSID
#define STASSID "Taufikk"
#define STAPSK  "1234567890"
#endif

int remotePort = 2000;                // inisialisasi port
client atau port NodeMCU Port
unsigned int localPort = 8888;// inisialisasi port komputer
```

```
IPAddress remoteIp(192,168,147,85);//inisialisasi IP
komputer

char packetBuffer[UDP_TX_PACKET_MAX_SIZE + 1]; //jeda
pengiriman data
WiFiUDP Udp;//variabel udp merupakan turunan dari library
wifi udp

ADXL345 adxl; //variabel adxl merupakan turunan dari
library adxl345

void setup(){
  Serial.begin(9600);// kecepatan data per bit
  WiFi.mode(WIFI_STA);// memulai pemanggilan wifi
  WiFi.begin(STASSID, STAPSK);// memulai pemanggilan wifi
  while (WiFi.status() != WL_CONNECTED) {// jika wifi tidak
terhubung akab muncul pesan titik titik
    Serial.print('.');
    delay(500);// delay 0,5 detik
  }
  Serial.print("Connected! IP address: ");// Jika wifi
terhubung dengan hotspot  akan muncul
  Serial.println(WiFi.localIP());// pesan pada serial
monitor
  Serial.printf("UDP server on port %d\n", localPort);//
Connected! IP address: berisikan IP komputer dan
  Udp.begin(localPort);// Protokol UDP dimulai

  adxl.powerOn();// mengaktifkan sensor adxl345

  //setting batasan aktif/ketidak aktifan (0-255)
  adxl.setActivityThreshold(75); //setting batas aktif adxl
```

```
  adxl.setInactivityThreshold(75); // setting batas aktif
ketidakaktifan  adxl
  adxl.setTimeInactivity(10); // Setting waktu tidak aktif
0,1 detik

  //look of activity movement on this axes - 1 == on; 0 ==
off
  adxl.setActivityX(1);// Melihat peregerakan aktif sumbu X
Y Z, jika 1 =on dan 0 = 0ff
  adxl.setActivityY(1);
  adxl.setActivityZ(1);

  //look of inactivity movement on this axes - 1 == on; 0
== off
  adxl.setInactivityX(1);// Melihat peregerakan tidak
aktif sumbu XYZ, jika 1 =on dan 0 = 0ff
  adxl.setInactivityY(1);
  adxl.setInactivityZ(1);

  //look of tap movement on this axes - 1 == on; 0 == off
  adxl.setTapDetectionOnX(0);
  adxl.setTapDetectionOnY(0);
  adxl.setTapDetectionOnZ(1);

  //setting nilai Threshold Average Precision (TAP):batasan
presisi rata-rata (0-255)
  adxl.setTapThreshold(50); // setting batas Threshold
Average Precision (TAP)
  adxl.setTapDuration(15); // setting durasi Threshold
Average Precision (TAP)
  adxl.setDoubleTapLatency(80); // setting pergerakan
Threshold Average Precision (TAP)
```

```
  adxl.setDoubleTapWindow(200); // setting Panjang
pergerakan Threshold Average Precision (TAP)


  //setting value nilai untuk gerak jatuh bebas (0-255)
  adxl.setFreeFallThreshold(7); //setting Batasan gerak
jatuh bebas 62.5miligravitasi per gerakan
  adxl.setFreeFallDuration(45); // setting durasi gerak
jatuh bebas 5m/s per gerakan


  //setting semua interrupts di atas
  adxl.setInterruptMapping( ADXL345_INT_SINGLE_TAP_BIT,
ADXL345_INT1_PIN ); // pemetaan interrupts, Single TAP
setara 6 Bit ke pin D1
  adxl.setInterruptMapping( ADXL345_INT_DOUBLE_TAP_BIT,
ADXL345_INT1_PIN ); // pemetaan interrupts, Double TAP
setara 5 Bit ke pin D1
  adxl.setInterruptMapping( ADXL345_INT_FREE_FALL_BIT,
ADXL345_INT1_PIN ); // pemetaan interrupts, gerak jatuh
bebas setara 2 Bit ke pin D1
  adxl.setInterruptMapping( ADXL345_INT_ACTIVITY_BIT,
ADXL345_INT1_PIN ); // pemetaan interrupts, activity setara
4 Bit ke pin D1
  adxl.setInterruptMapping( ADXL345_INT_INACTIVITY_BIT,
ADXL345_INT1_PIN ); // pemetaan interrupts, inactivity
setara 3 Bit ke pin D1


  //register interrupt aktif - 1 == on; 0 == off
  adxl.setInterrupt( ADXL345_INT_SINGLE_TAP_BIT, 1);
//setting interrupt , Single TAP setara 6 Bit on
```

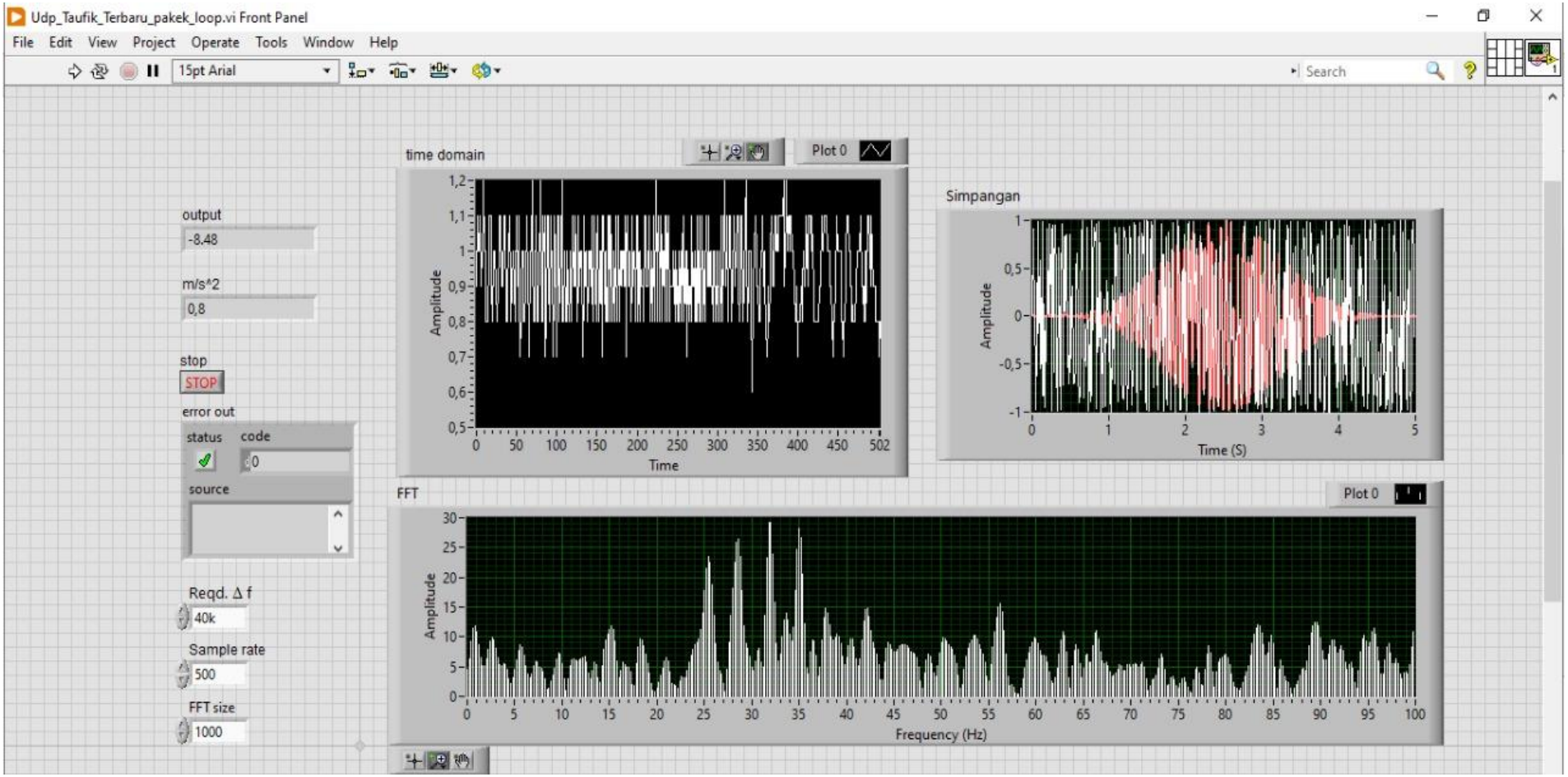
```
  adxl.setInterrupt( ADXL345_INT_DOUBLE_TAP_BIT, 1);
//setting interrupt , double TAP setara 5 Bit on
  adxl.setInterrupt( ADXL345_INT_FREE_FALL_BIT,  1);
//setting interrupt , gerak jatuh bebas setara 2 Bit on
  adxl.setInterrupt( ADXL345_INT_ACTIVITY_BIT,   1);
//setting interrupt , activity setara 4 Bit on
  adxl.setInterrupt( ADXL345_INT_INACTIVITY_BIT, 1);
//setting interrupt , inactivity setara 3 Bit on

}
void loop(){
  // Output asli  x,y,z values dalam bentuk bit data
  int x,y,z;  // masukkan inputan sumbu XYZ
  adxl.readXYZ(&x, &y, &z); //membaca nilai accelerometer
dan variabel XYZ
  Serial.print(x); // print nilai x
  Serial.print("  ");
  Serial.print(y); //print nilai x
  Serial.print("  ");
  Serial.println(z); //print nilai x

  double xyz[3];
  double ax,ay,az;
  adxl.getAcceleration(xyz);
  ax = (xyz[0]*98);
  ay = (xyz[1]*98);
  az = (xyz[2]*98);// keterangan tersebut Merubah nilai
asli keluaran sensor menjadi bentuk percepatan dengan
satuan m/s^2
  Serial.print("X="); //print percepatan sumbu  x
  Serial.print(ax); //print percepatan sumbu  x
  Serial.println("m/s^2");//print satuan percepatan sumbu x
  Serial.print("Y=");//print percepatan sumbu   y
```

```
  Serial.print(ay); //print percepatan sumbu  y
  Serial.println("m/s^2");//print satuan percepatan sumbu y
  Serial.print("Z="); //print percepatan sumbu  z
  Serial.print(az); //print percepatan sumbu  z
  Serial.println("m/s^2");//print satuan percepatan sumbu z

  Serial.println("**********************");
  delay(500);

  Udp.beginPacket(remoteIp,remotePort);
  Udp.println(ax);
  Udp.endPacket();
  delay(500);// digunakan untuk mengirim data percepatan ke
labview
}
```

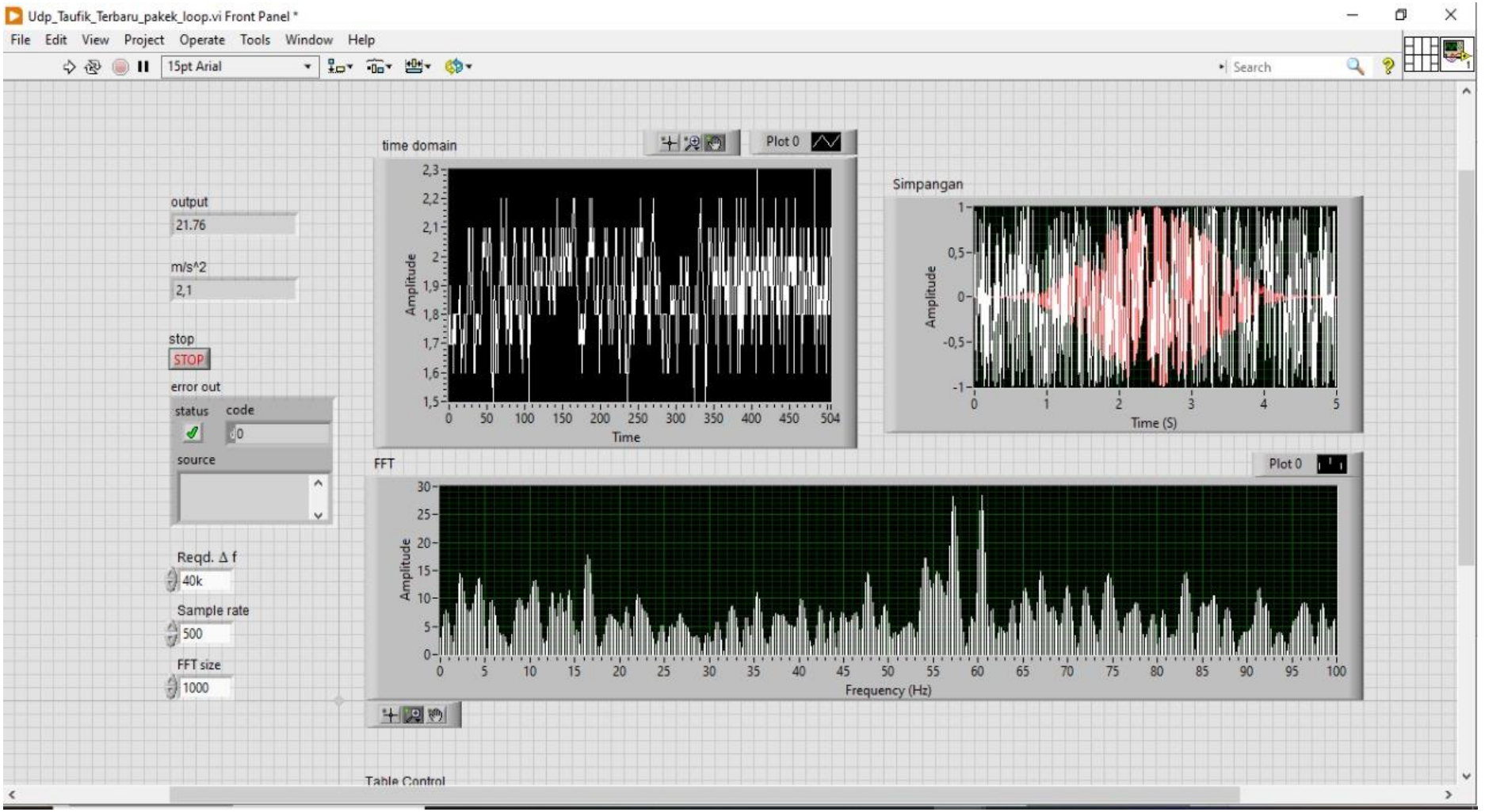
Lampiran 5

Data Uji Karakteristik Alat Ukur Vibrasi

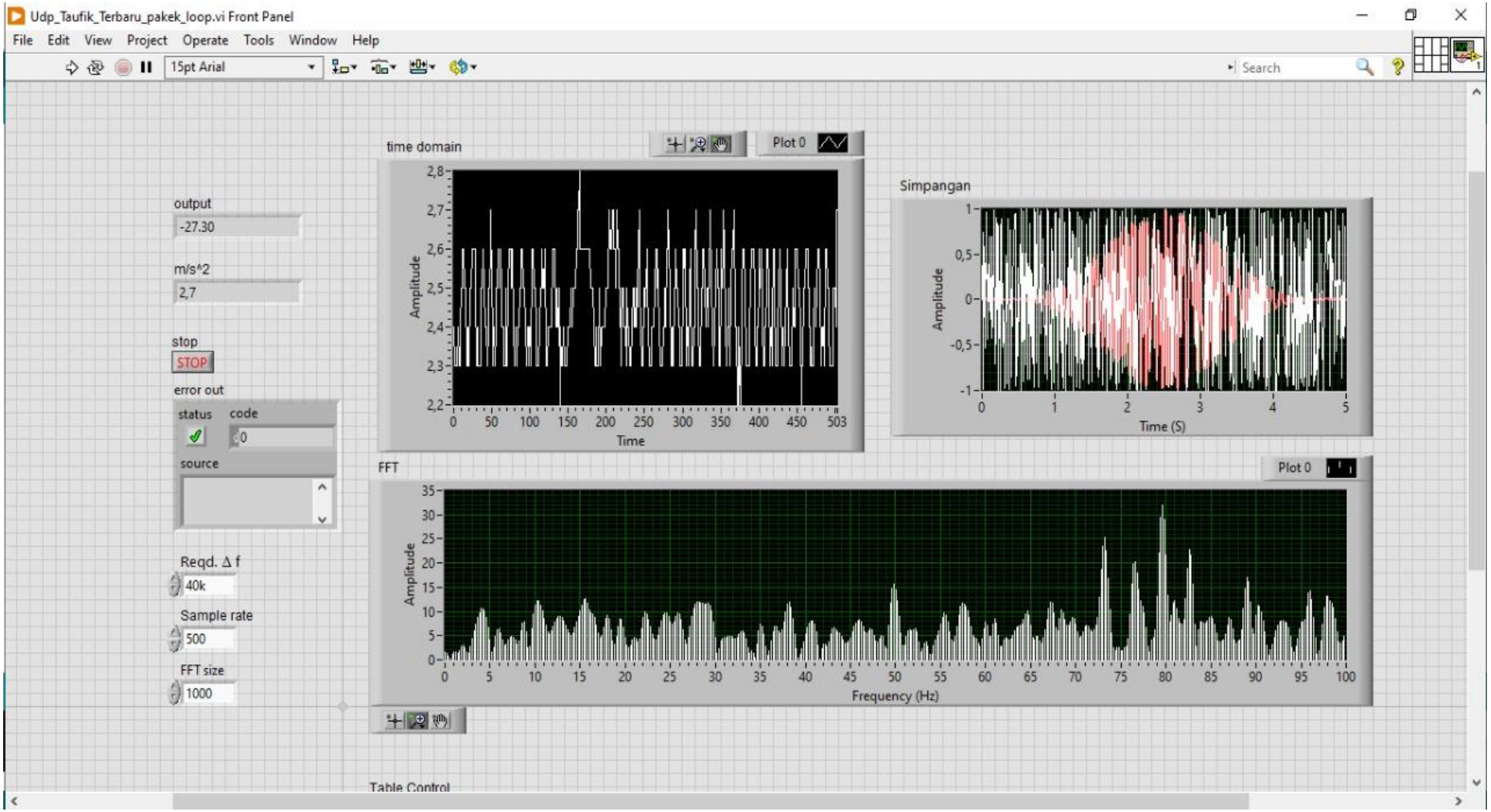
1. Perulangan 1 m/s2



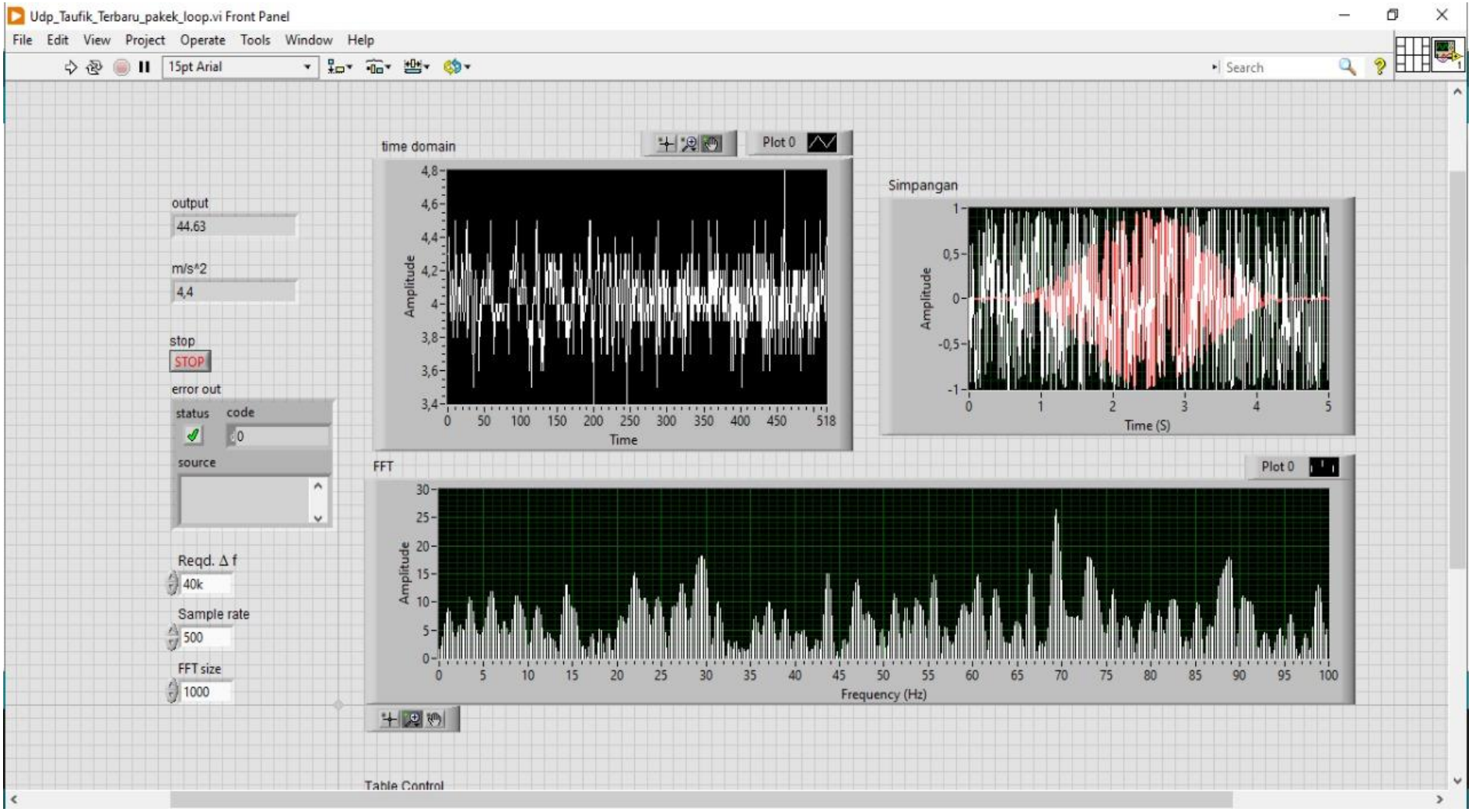
2. Perulangan 2 m/s^2



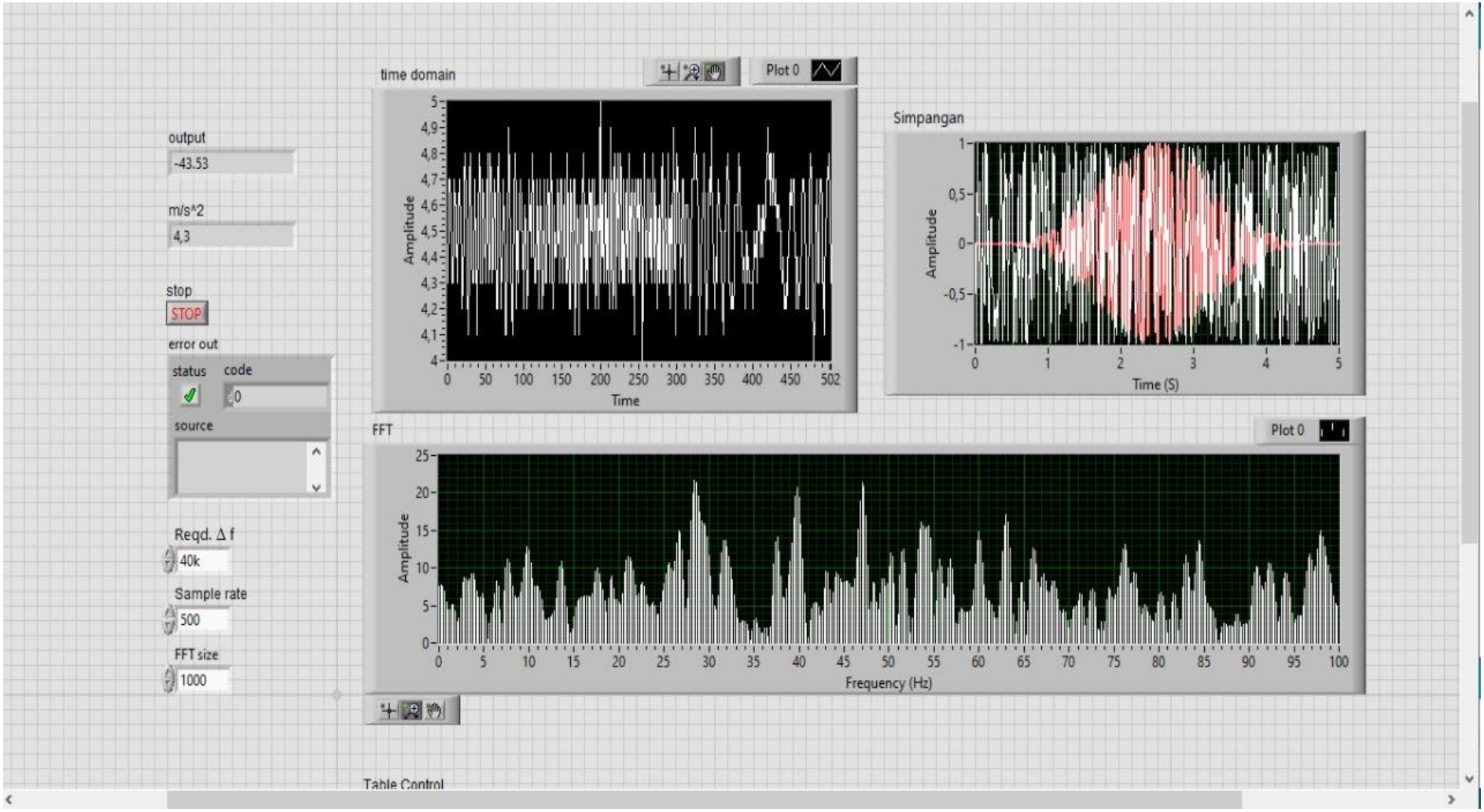
3. Perulangan 3 m/s^2



4. Perulangan 4 m/s^2



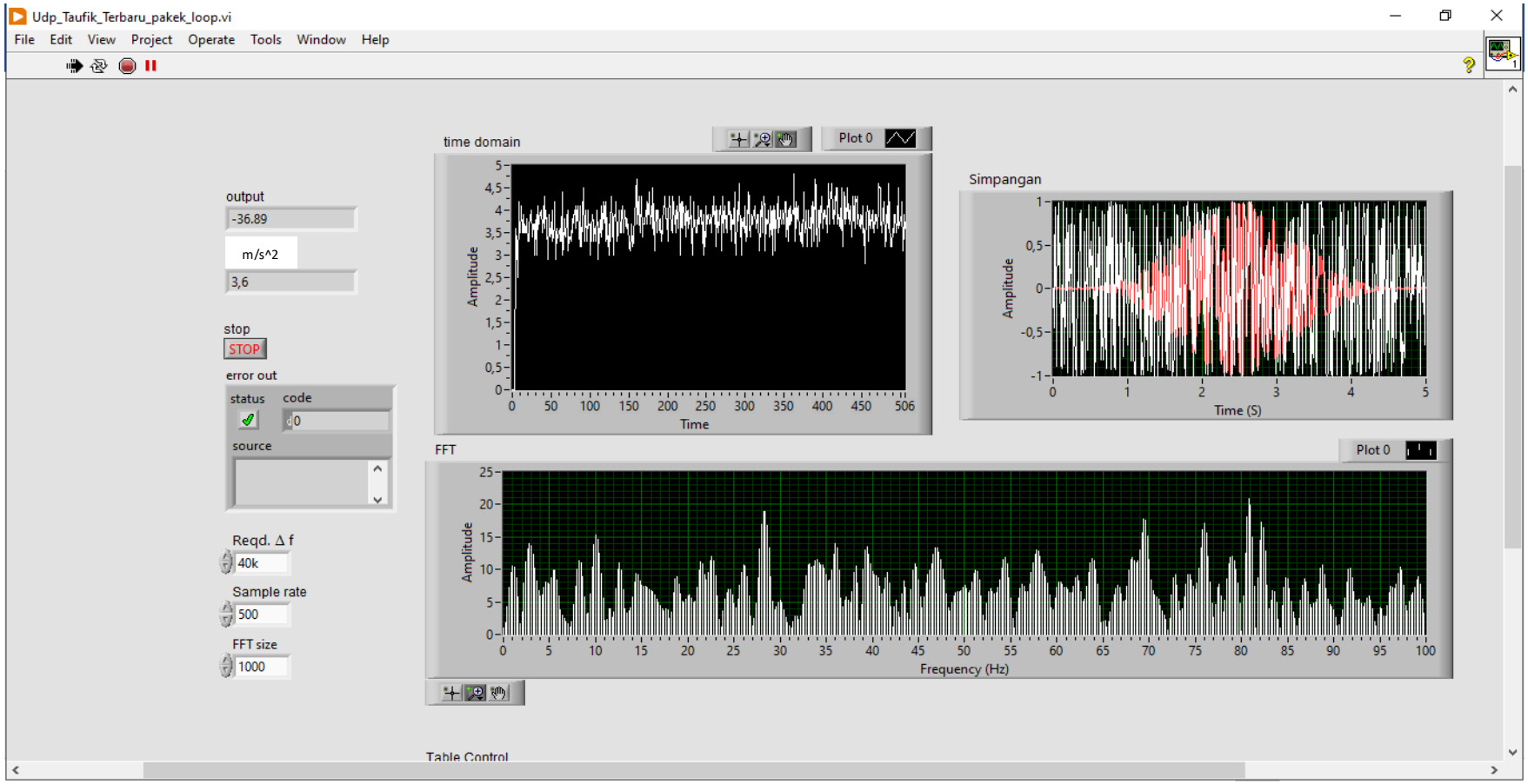
5. Perulangan 5 m/s^2



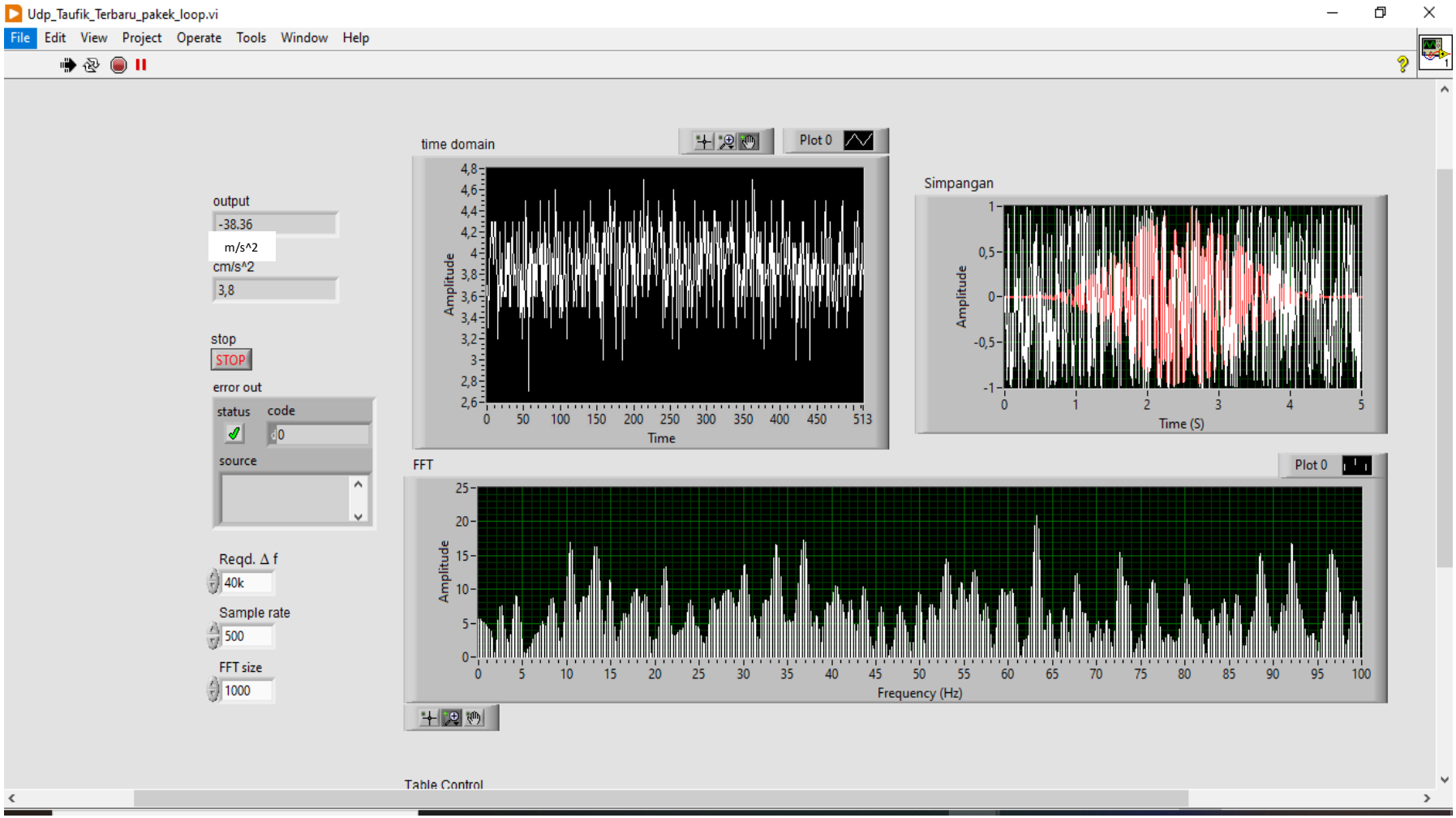
Lampiran 6

Data Vibrasi Induced Draft Fan Berdasarkan Wi-Fi

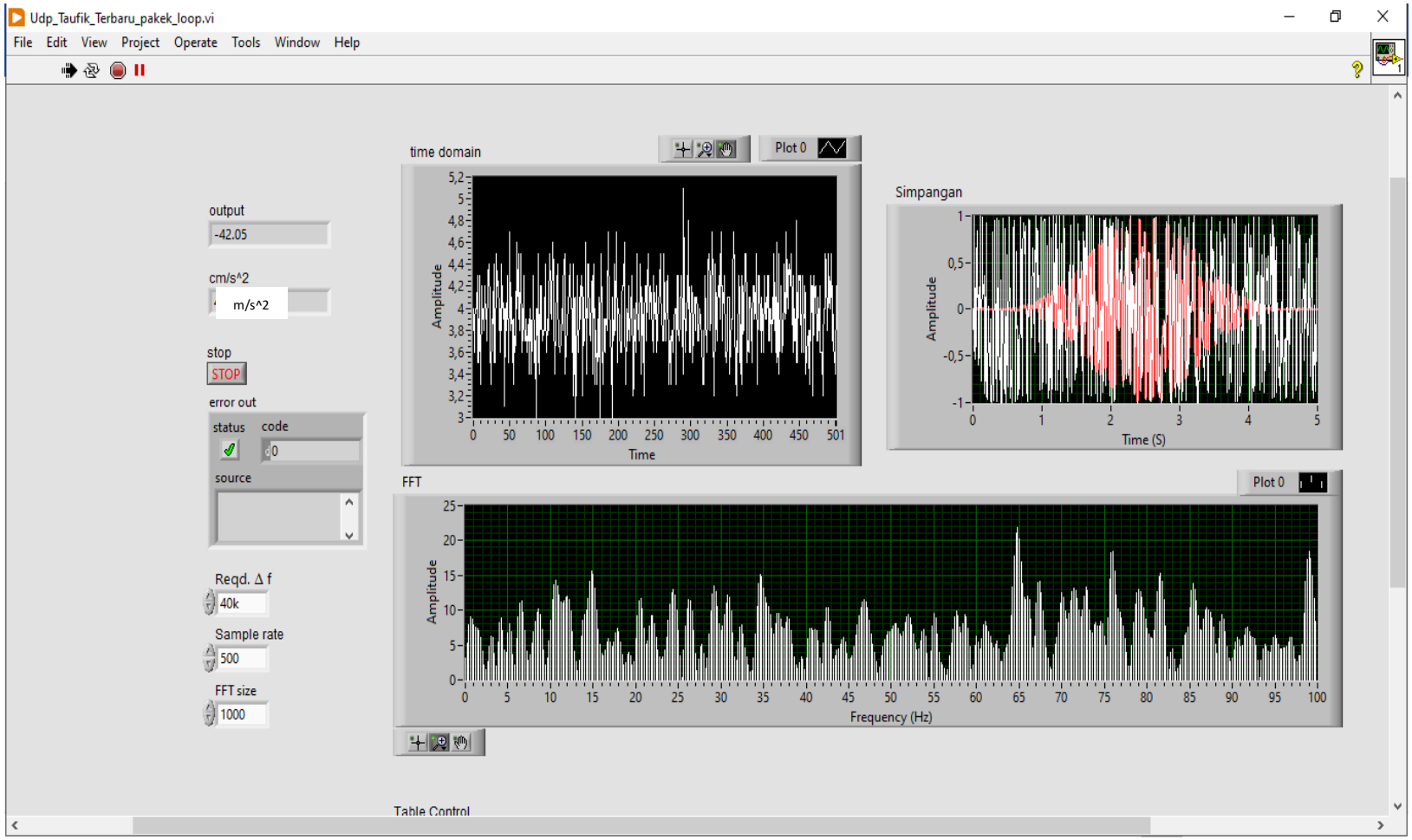
1. Jarak 10 Meter



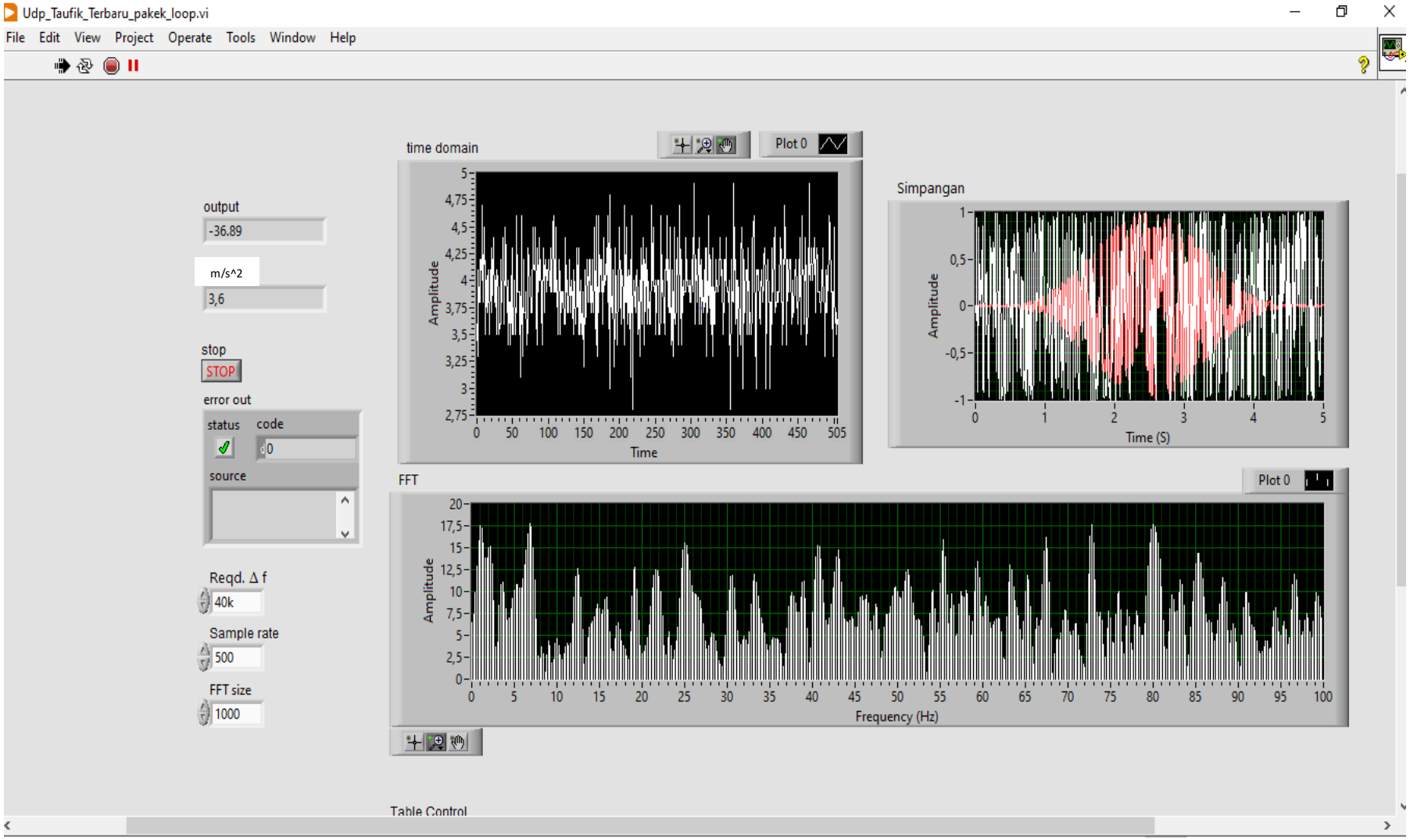
2. Jarak 20 Meter



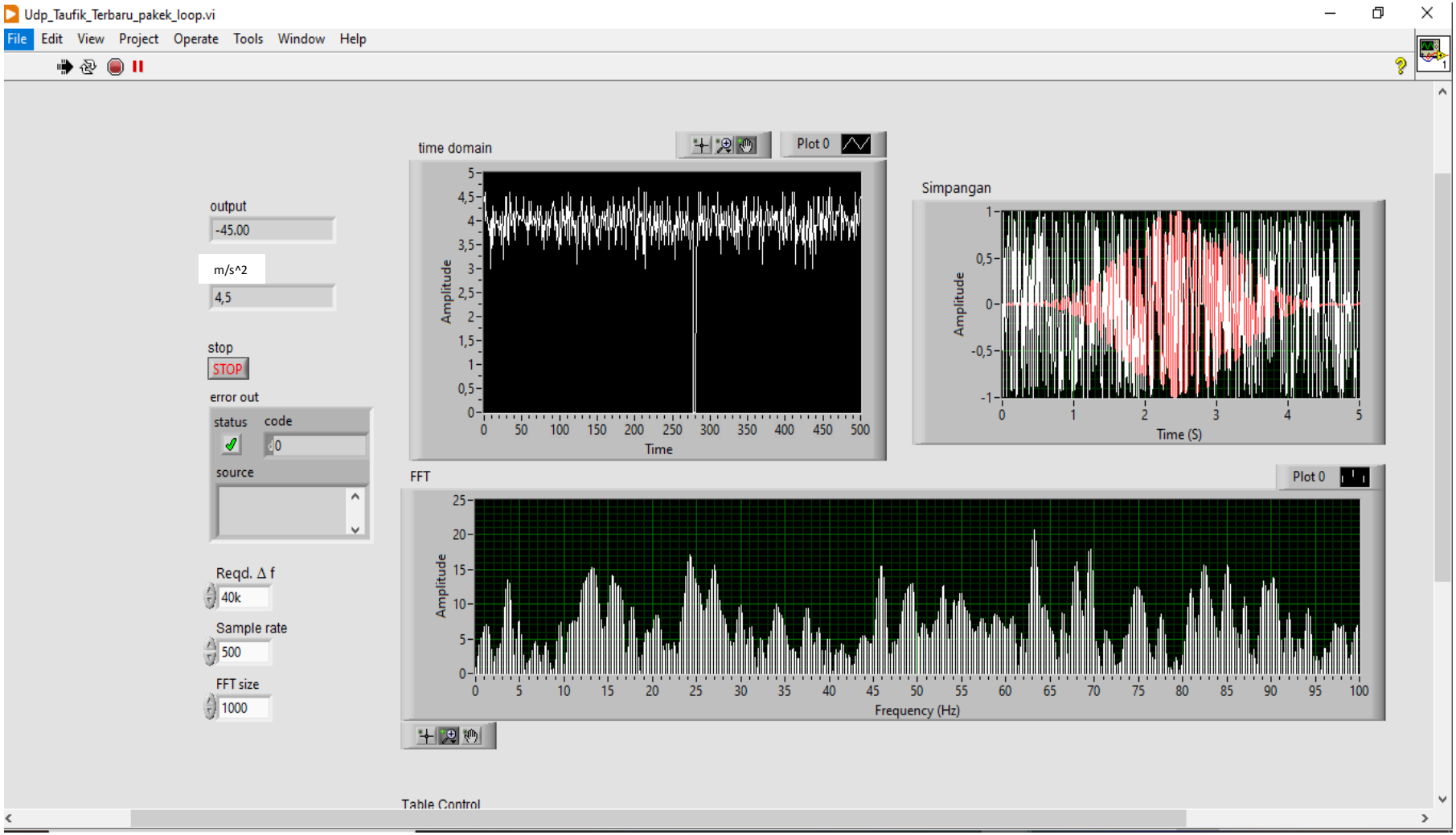
3. Jarak 30 Meter



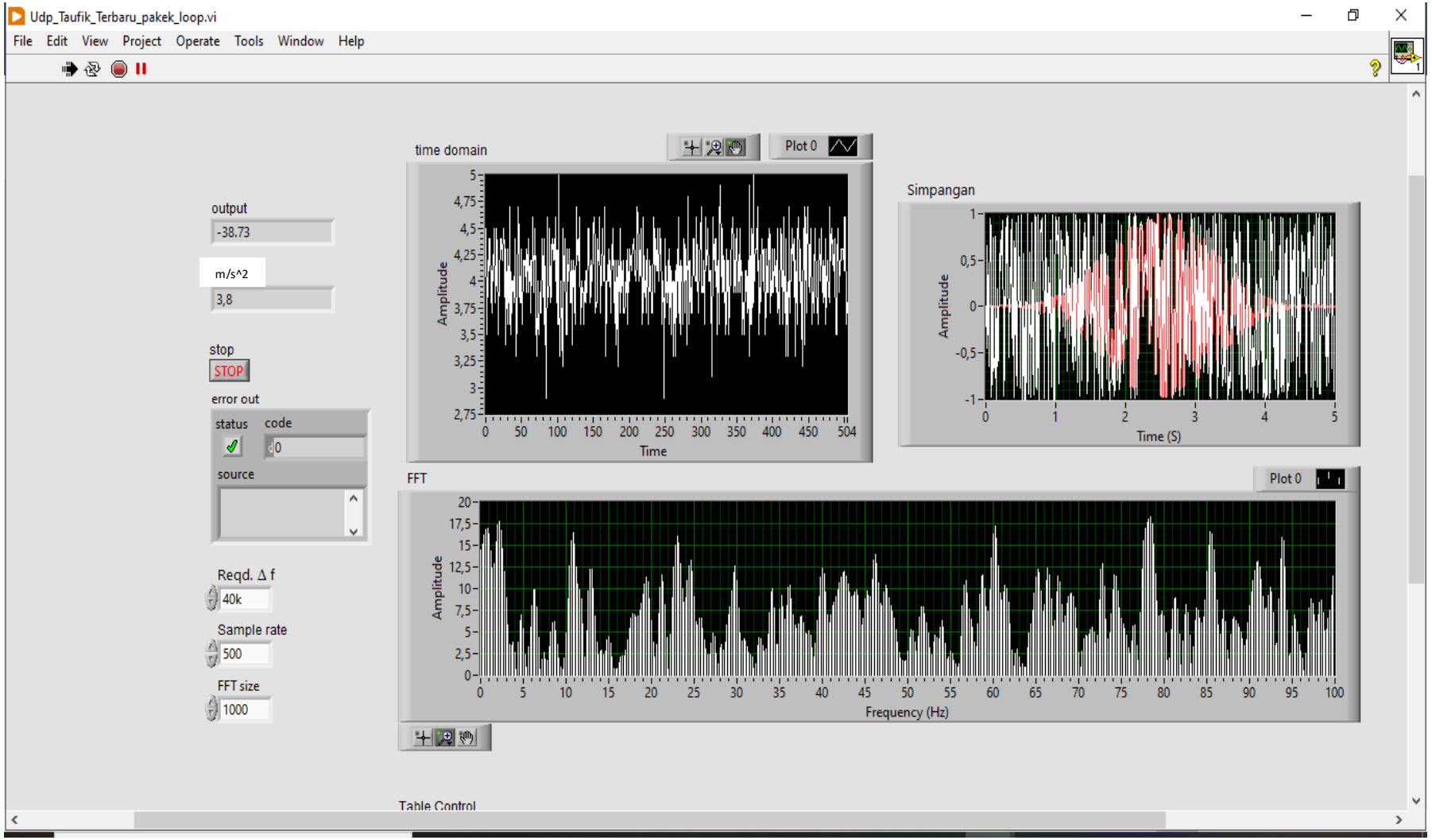
4. Jarak 40 Meter



5. Jarak 50 Meter



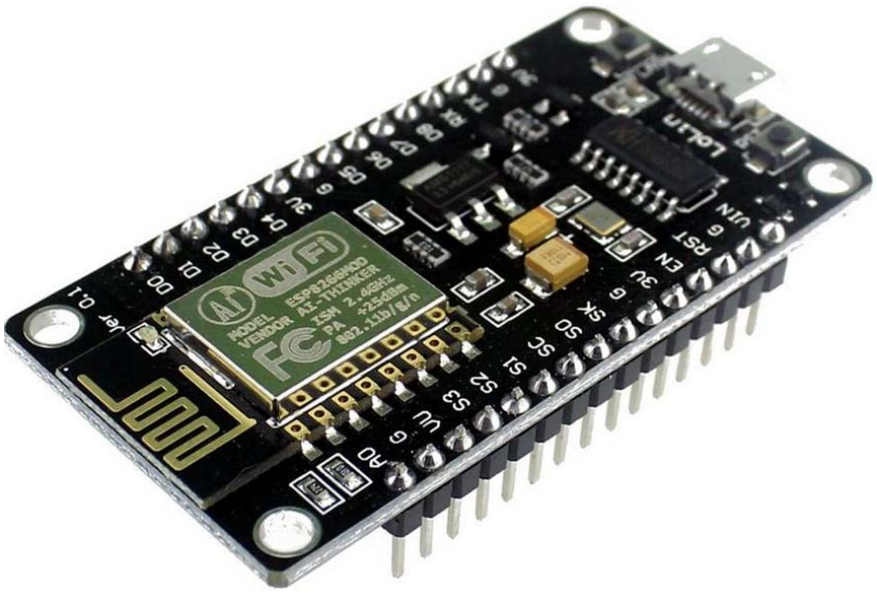
6. Jarak 80 Meter



Handson Technology

User Manual V1.2

ESP8266 NodeMCU WiFi Devkit



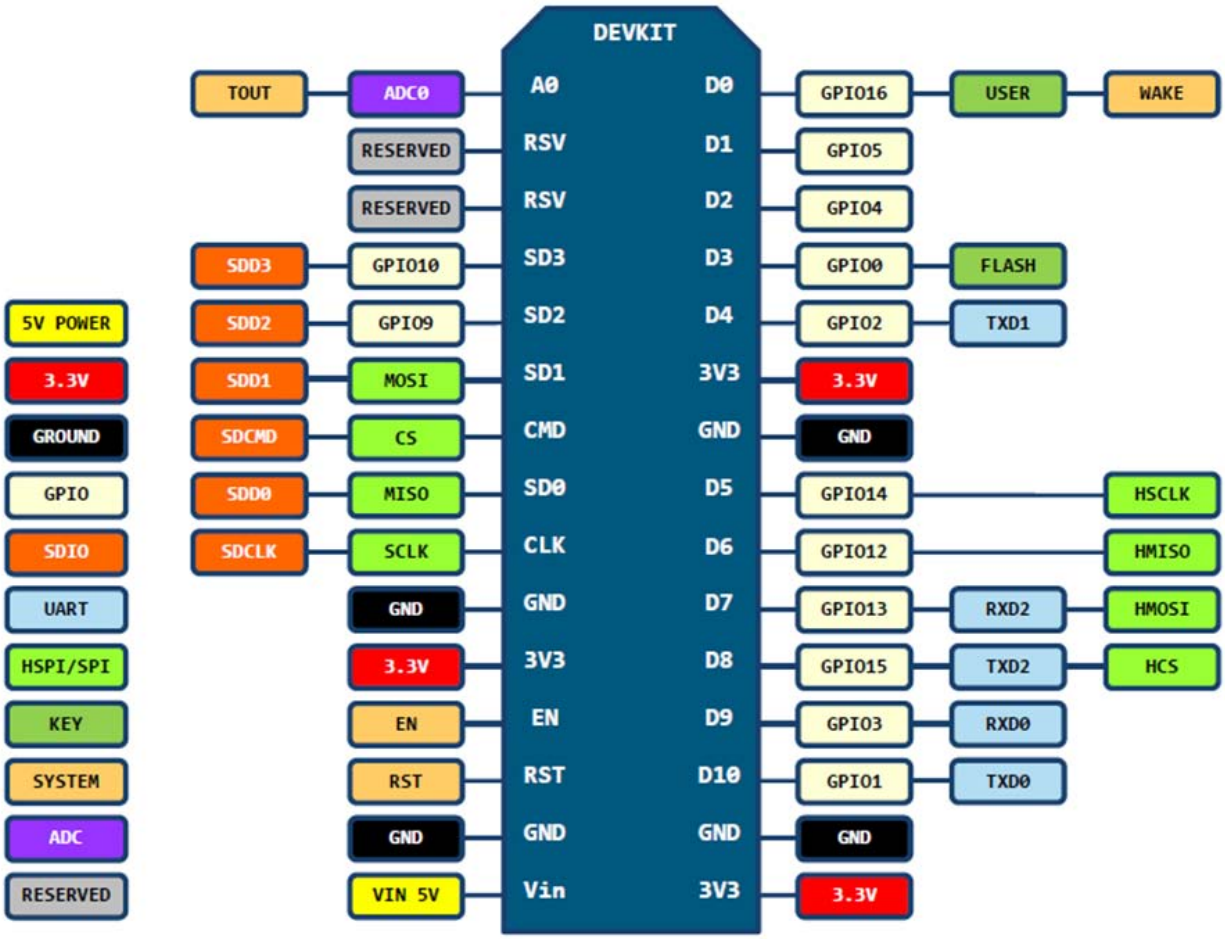
The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications.

This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

1. Specification:

- Voltage:3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption: 10uA~170mA.
- Flash memory attachable: 16MB max (512K normal).
- Integrated TCP/IP protocol stack.
- Processor: Tensilica L106 32-bit.
- Processor speed: 80~160MHz.
- RAM: 32K + 80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode
- 802.11 support: b/g/n.
- Maximum concurrent TCP connections: 5.

2. Pin Definition:



D0(GPIO16) can only be used as gpio read/write, no interrupt supported, no pwm/i2c/ow supported.

3. Using Arduino IDE

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a WiFi/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to install ESP8266 library to work in Arduino IDE environment.

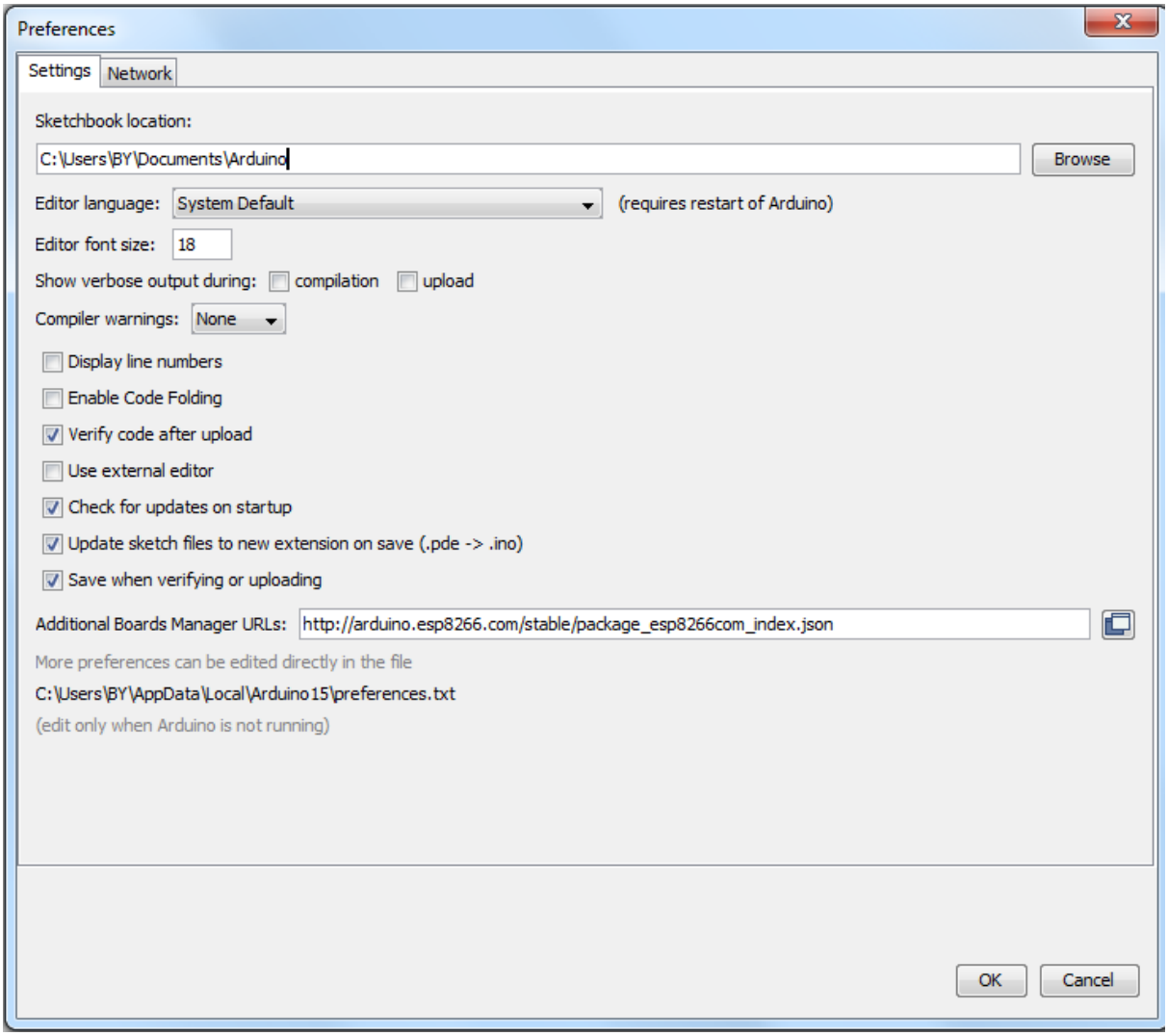
3.1 Install the Arduino IDE 1.6.4 or greater

Download Arduino IDE from Arduino.cc (1.6.4 or greater) - don't use 1.6.2 or lower version! You can use your existing IDE if you have already installed it.

You can also try downloading the ready-to-go package from the ESP8266-Arduino project, if the proxy is giving you problems.

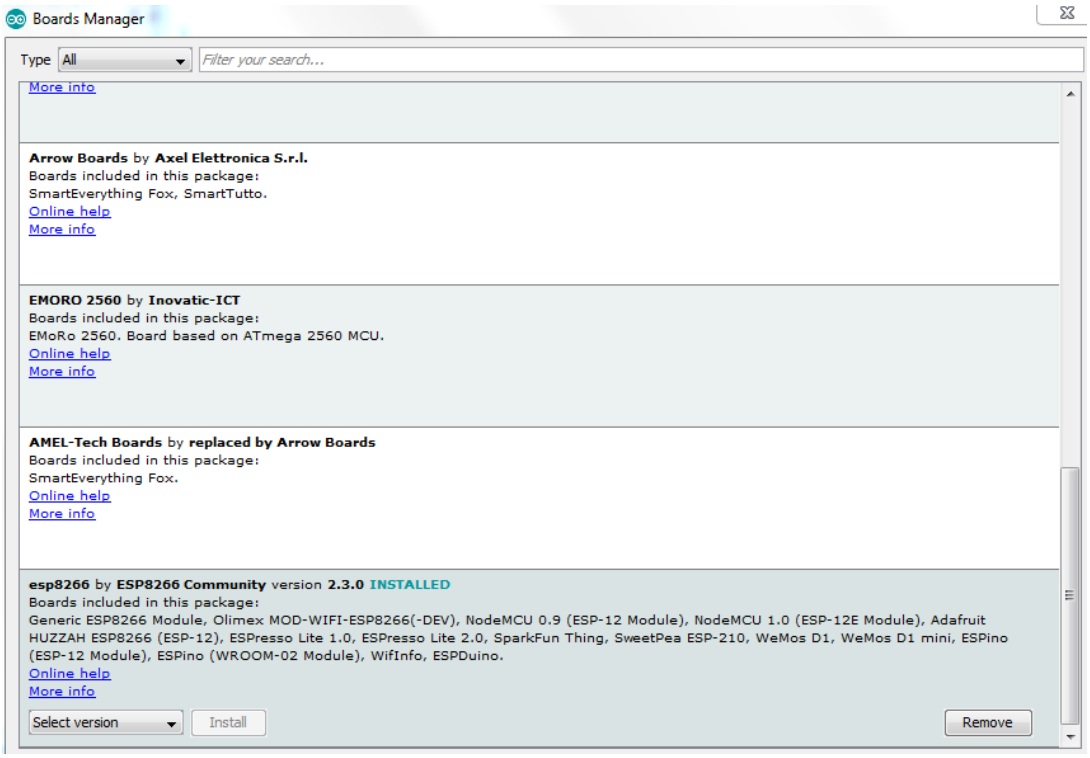
3.2 Install the ESP8266 Board Package

Enter ***http://arduino.esp8266.com/stable/package_esp8266com_index.json*** into *Additional Board Manager URLs* field in the Arduino v1.6.4+ preferences.



Click 'File' -> 'Preferences' to access this panel.

Next, use the Board manager to install the ESP8266 package.

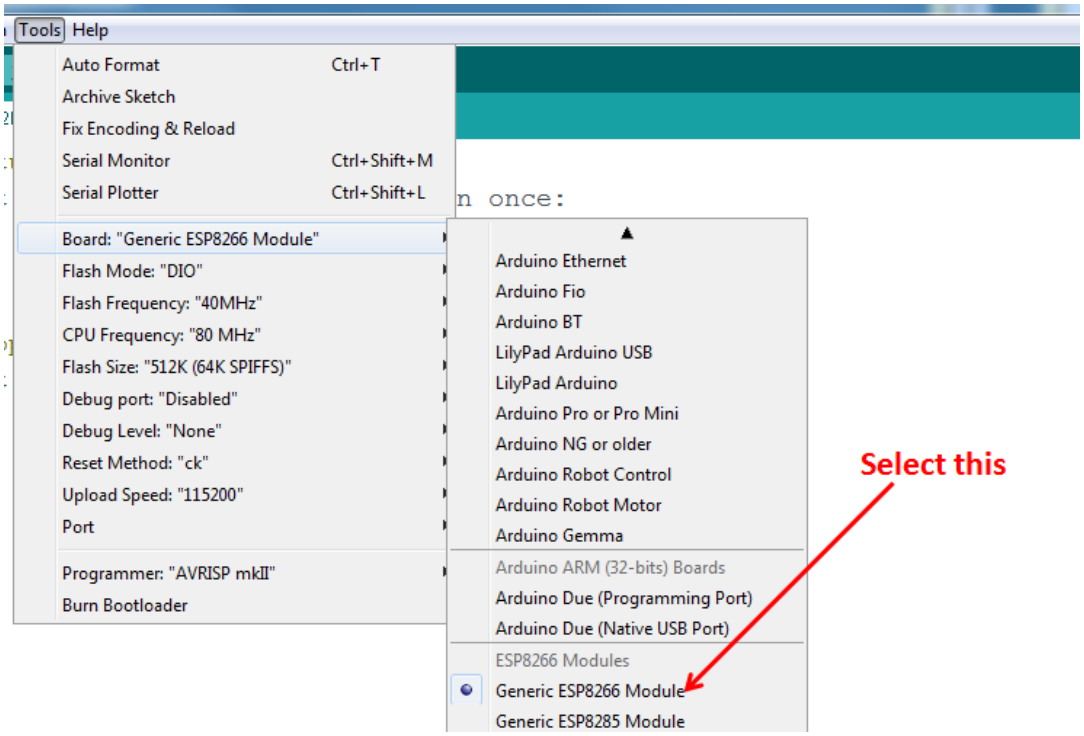


Click 'Tools' -> 'Board:' -> 'Board Manager…' to access this panel.

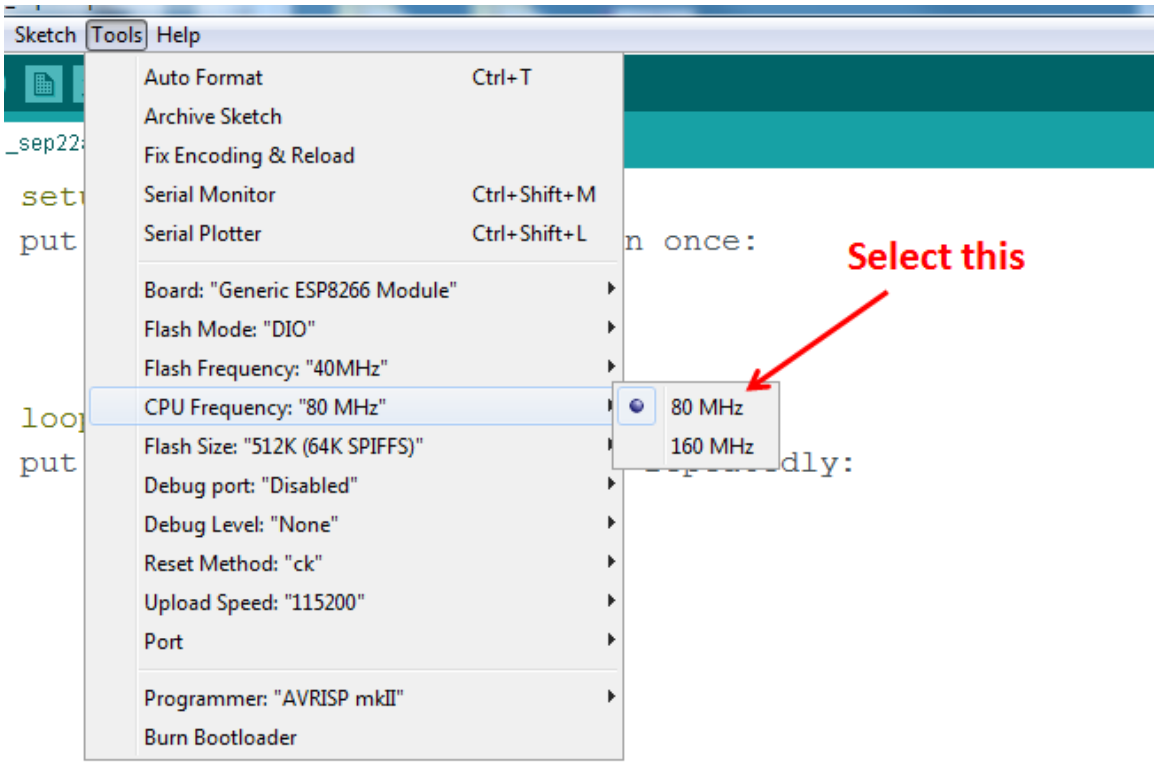
Scroll down to ' esp8266 by ESP8266 Community ' and click "Install" button to install the ESP8266 library package. Once installation completed, close and re-open Arduino IDE for ESP8266 library to take effect.

3.3 Setup ESP8266 Support

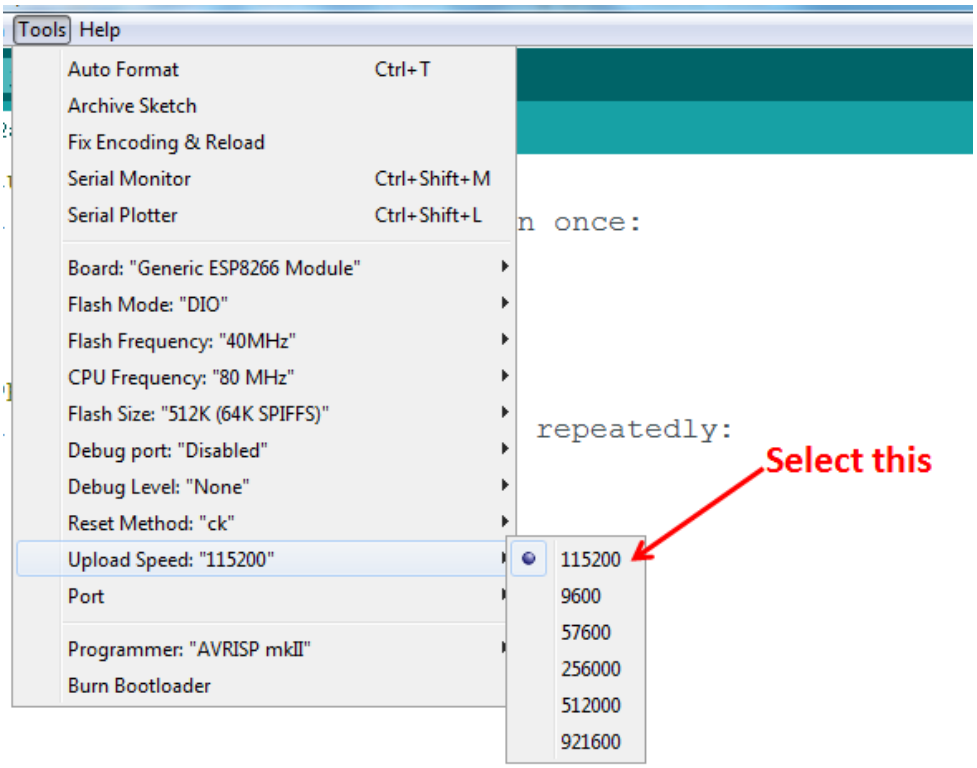
When you've restarted Arduino IDE, select 'Generic ESP8266 Module' from the 'Tools' -> 'Board:' dropdown menu.



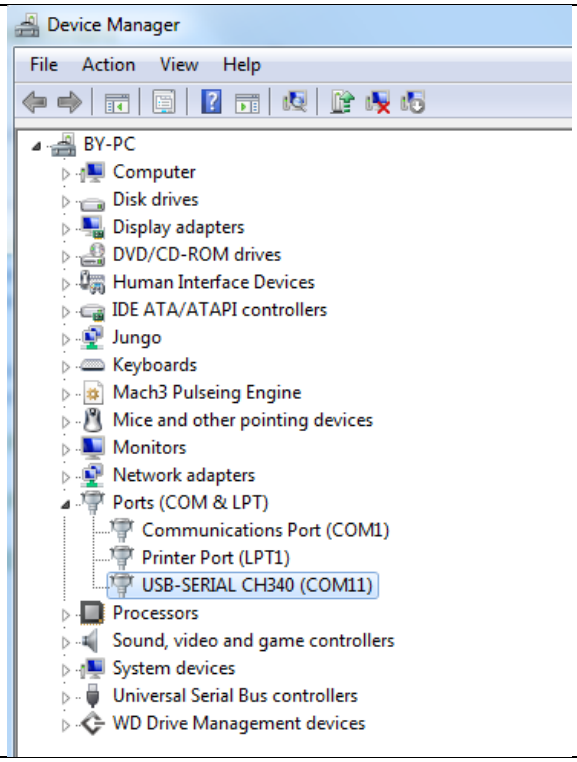
Select 80 MHz as the CPU frequency (you can try 160 MHz overclock later)



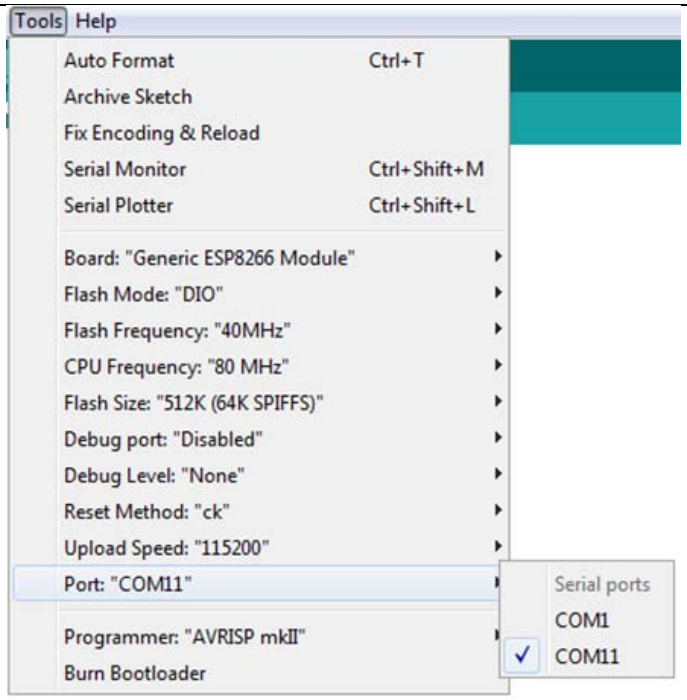
Select '115200' baud upload speed is a good place to start - later on you can try higher speeds but 115200 is a good safe place to start.



Go to your Windows 'Device Manager' to find out which Com Port 'USB-Serial CH340' is assigned to. Select the matching COM/serial port for your CH340 USB-Serial interface.



Find out which Com Port is assign for CH340



Select the correct Com Port as indicated on 'Device Manager"

Note: if this is your first time using CH340 " USB-to-Serial " interface, please install the driver first before proceed the above Com Port setting. The CH340 driver can be download from the below site:

https://github.com/nodemcu/nodemcu-devkit/tree/master/Drivers

3.4 Blink Test

We'll begin with the simple blink test.

Enter this into the sketch window (and save since you'll have to). Connect a LED as shown in Figure3-1.

```
void setup() {
  pinMode(5, OUTPUT);   // GPIO05, Digital Pin D1
}

void loop() {
  digitalWrite(5, HIGH);
  delay(900);
  digitalWrite(5, LOW);
  delay(500);
}
```

Now you'll need to put the board into bootload mode. You'll have to do this before each upload. There is no timeout for bootload mode, so you don't have to rush!

- Hold down the 'Flash' button.
- While holding down ' Flash', press the 'RST' button.
- Release 'RST', then release 'Flash'

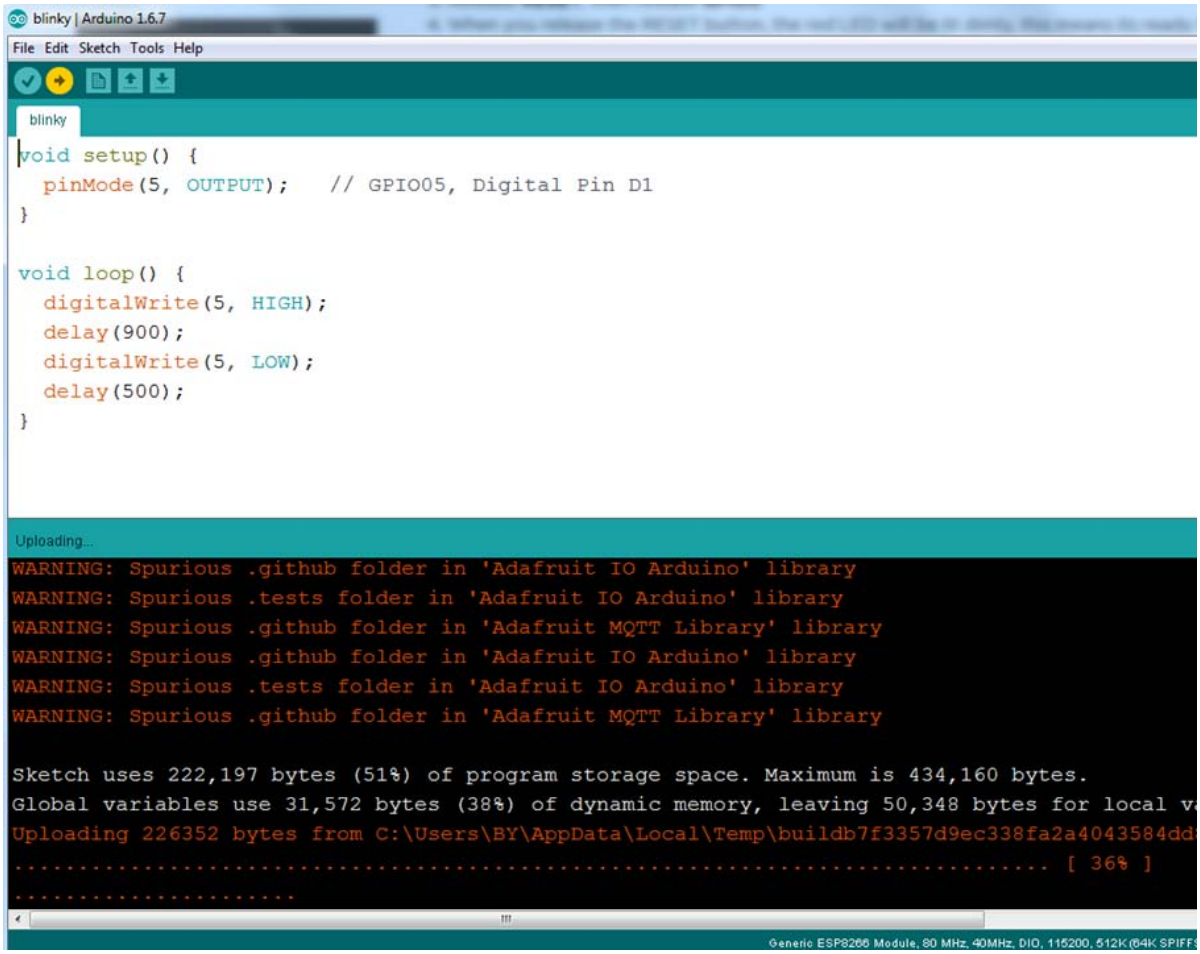


Figure 3.2: Uploading the sketch to ESP8266 NodeMCU module.

The sketch will start immediately - you'll see the LED blinking. Hooray!

3.5 Connecting via WiFi

OK once you've got the LED blinking, let's go straight to the fun part, connecting to a webserver. Create a new sketch with this code:

Don't forget to update:

const char* ssid = "yourssid";

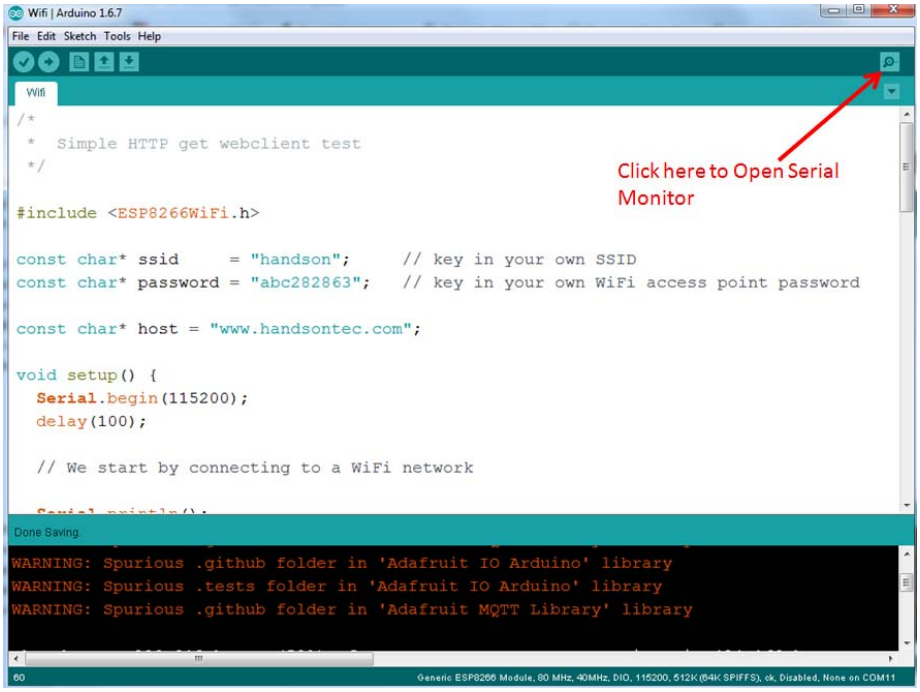
const char* password = "yourpassword";

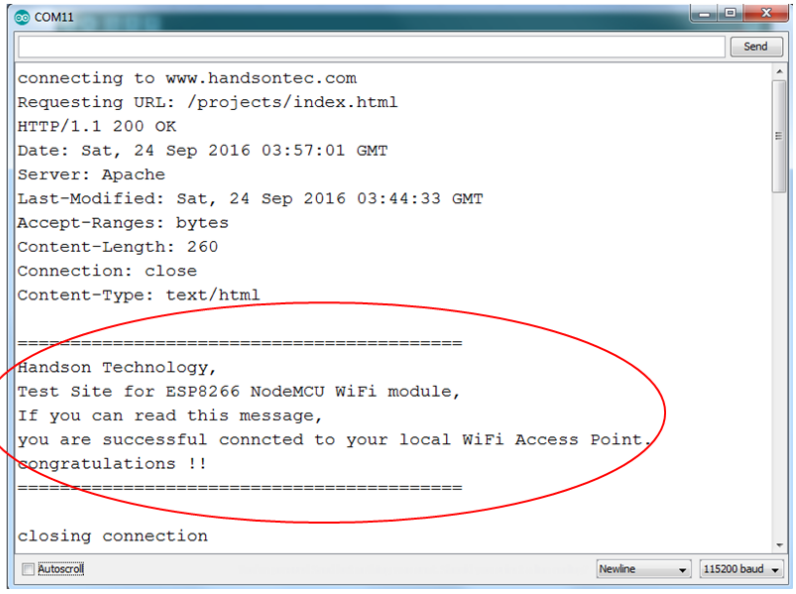
to your WiFi access point and password, then upload the same way: get into bootload mode, then upload code via IDE.

```
/*
 *  Simple HTTP get webclient test
 */

#include <ESP8266WiFi.h>

const char* ssid     = "handson";     // key in your own SSID
const char* password = "abc1234";     // key in your own WiFi access point
password
```

```
const char* host = "www.handsontec.com";

void setup() {
  Serial.begin(115200);
  delay(100);

  // We start by connecting to a WiFi network

  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);

  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }

  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

int value = 0;

void loop() {
  delay(5000);
  ++value;

  Serial.print("connecting to ");
  Serial.println(host);

  // Use WiFiClient class to create TCP connections
  WiFiClient client;
  const int httpPort = 80;
  if (!client.connect(host, httpPort)) {
    Serial.println("connection failed");
    return;
  }

  // We now create a URI for the request
  String url = "/projects/index.html";
  Serial.print("Requesting URL: ");
  Serial.println(url);

  // This will send the request to the server
  client.print(String("GET ") + url + " HTTP/1.1\r\n" +
               "Host: " + host + "\r\n" +
               "Connection: close\r\n\r\n");
  delay(500);

  // Read all the lines of the reply from server and print them to Serial
  while(client.available()){
    String line = client.readStringUntil('\r');
    Serial.print(line);
  }

  Serial.println();
  Serial.println("closing connection");
}
```

Open up the IDE serial console at 115200 baud to see the connection and webpage printout!





That's it, pretty easy right ! This section is just to get you started and test out your module.

3-Axis, ±2 *g*/±4 *g*/±8 *g*/±16 *g* Digital Accelerometer

Data Sheet

ADXL345

FEATURES

- Ultralow power: as low as 23 µA in measurement mode and 0.1 µA in standby mode at V_S = 2.5 V (typical)
- Power consumption scales automatically with bandwidth
- User-selectable resolution
  - Fixed 10-bit resolution
  - Full resolution, where resolution increases with *g* range, up to 13-bit resolution at ±16 *g* (maintaining 4 mg/LSB scale factor in all *g* ranges)
- Embedded memory management system with FIFO technology minimizes host processor load
- Single tap/double tap detection
- Activity/inactivity monitoring
- Free-fall detection
- Supply voltage range: 2.0 V to 3.6 V
- I/O voltage range: 1.7 V to V_S
- SPI (3- and 4-wire) and I^2C digital interfaces
- Flexible interrupt modes mappable to either interrupt pin
- Measurement ranges selectable via serial command
- Bandwidth selectable via serial command
- Wide temperature range (−40°C to +85°C)
- 10,000 *g* shock survival
- Pb free/RoHS compliant
- Small and thin: 3 mm × 5 mm × 1 mm LGA package

APPLICATIONS

- Handsets
- Medical instrumentation
- Gaming and pointing devices
- Industrial instrumentation
- Personal navigation devices
- Hard disk drive (HDD) protection

GENERAL DESCRIPTION

The ADXL345 is a small, thin, ultralow power, 3-axis accelerometer with high resolution (13-bit) measurement at up to ±16 *g*. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3- or 4-wire) or I^2C digital interface.

The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (3.9 mg/LSB) enables measurement of inclination changes less than 1.0°.

Several special sensing functions are provided. Activity and inactivity sensing detect the presence or lack of motion by comparing the acceleration on any axis with user-set thresholds. Tap sensing detects single and double taps in any direction. Free-fall sensing detects if the device is falling. These functions can be mapped individually to either of two interrupt output pins. An integrated memory management system with a 32-level first in, first out (FIFO) buffer can be used to store data to minimize host processor activity and lower overall system power consumption.

Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation.

The ADXL345 is supplied in a small, thin, 3 mm × 5 mm × 1 mm, 14-lead, plastic package.

FUNCTIONAL BLOCK DIAGRAM

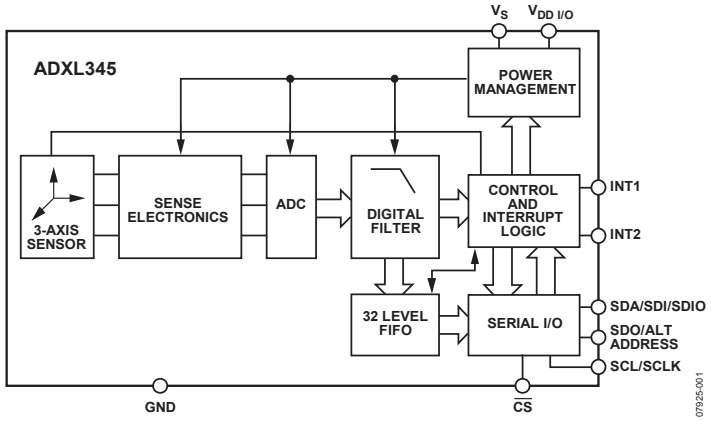


Figure 1.

Rev. E

Document Feedback

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Technical Support www.analog.com

SPECIFICATIONS

T_A = 25°C, V_S = 2.5 V, $V_{DD\ I/O}$ = 1.8 V, acceleration = 0 *g*, C_S = 10 µF tantalum, $C_{I/O}$ = 0.1 µF, output data rate (ODR) = 800 Hz, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

Parameter	Test Conditions	Min	Typ[1]	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range	User selectable		±2, ±4, ±8, ±16		*g*
Nonlinearity	Percentage of full scale		±0.5		%
Inter-Axis Alignment Error			±0.1		Degrees
Cross-Axis Sensitivity[2]			±1		%
OUTPUT RESOLUTION	Each axis				
All *g* Ranges	10-bit resolution		10		Bits
±2 *g* Range	Full resolution		10		Bits
±4 *g* Range	Full resolution		11		Bits
±8 *g* Range	Full resolution		12		Bits
±16 *g* Range	Full resolution		13		Bits
SENSITIVITY	Each axis				
Sensitivity at X_{OUT}, Y_{OUT}, Z_{OUT}	All *g*-ranges, full resolution	230	256	282	LSB/*g*
	±2 *g*, 10-bit resolution	230	256	282	LSB/*g*
	±4 *g*, 10-bit resolution	115	128	141	LSB/*g*
	±8 *g*, 10-bit resolution	57	64	71	LSB/*g*
	±16 *g*, 10-bit resolution	29	32	35	LSB/*g*
Sensitivity Deviation from Ideal	All *g*-ranges		±1.0		%
Scale Factor at X_{OUT}, Y_{OUT}, Z_{OUT}	All *g*-ranges, full resolution	3.5	3.9	4.3	mg/LSB
	±2 *g*, 10-bit resolution	3.5	3.9	4.3	mg/LSB
	±4 *g*, 10-bit resolution	7.1	7.8	8.7	mg/LSB
	±8 *g*, 10-bit resolution	14.1	15.6	17.5	mg/LSB
	±16 *g*, 10-bit resolution	28.6	31.2	34.5	mg/LSB
Sensitivity Change Due to Temperature			±0.01		%/°C
0 *g* OFFSET	Each axis				
0 *g* Output for X_{OUT}, Y_{OUT}		−150	0	+150	m*g*
0 *g* Output for Z_{OUT}		−250	0	+250	m*g*
0 *g* Output Deviation from Ideal, X_{OUT}, Y_{OUT}			±35		m*g*
0 *g* Output Deviation from Ideal, Z_{OUT}			±40		m*g*
0 *g* Offset vs. Temperature for X-, Y-Axes			±0.4		mg/°C
0 *g* Offset vs. Temperature for Z-Axis			±1.2		mg/°C
NOISE					
X-, Y-Axes	ODR = 100 Hz for ±2 *g*, 10-bit resolution or all *g*-ranges, full resolution		0.75		LSB rms
Z-Axis	ODR = 100 Hz for ±2 *g*, 10-bit resolution or all *g*-ranges, full resolution		1.1		LSB rms
OUTPUT DATA RATE AND BANDWIDTH	User selectable				
Output Data Rate (ODR)[3, 4, 5]		0.1		3200	Hz
SELF-TEST[6]					
Output Change in X-Axis		0.20		2.10	*g*
Output Change in Y-Axis		−2.10		−0.20	*g*
Output Change in Z-Axis		0.30		3.40	*g*
POWER SUPPLY					
Operating Voltage Range (V_S)		2.0	2.5	3.6	V
Interface Voltage Range ($V_{DD\ I/O}$)		1.7	1.8	V_S	V
Supply Current	ODR ≥ 100 Hz		140		µA
	ODR < 10 Hz		30		µA
Standby Mode Leakage Current			0.1		µA
Turn-On and Wake-Up Time[7]	ODR = 3200 Hz		1.4		ms

Parameter	Test Conditions	Min	Typ[1]	Max	Unit
TEMPERATURE					
Operating Temperature Range		−40		+85	°C
WEIGHT					
Device Weight			30		m*g*

[1] The typical specifications shown are for at least 68% of the population of parts and are based on the worst case of mean ±1 σ, except for 0 *g* output and sensitivity, which represents the target value. For 0 *g* offset and sensitivity, the deviation from the ideal describes the worst case of mean ±1 σ.
[2] Cross-axis sensitivity is defined as coupling between any two axes.
[3] Bandwidth is the −3 dB frequency and is half the output data rate, bandwidth = ODR/2.
[4] The output format for the 3200 Hz and 1600 Hz ODRs is different than the output format for the remaining ODRs. This difference is described in the Data Formatting of Upper Data Rates section.
[5] Output data rates below 6.25 Hz exhibit additional offset shift with increased temperature, depending on selected output data rate. Refer to the Offset Performance at Lowest Data Rates section for details.
[6] Self-test change is defined as the output (*g*) when the SELF_TEST bit = 1 (in the DATA_FORMAT register, Address 0x31) minus the output (*g*) when the SELF_TEST bit = 0. Due to device filtering, the output reaches its final value after 4 × τ when enabling or disabling self-test, where τ = 1/(data rate). The part must be in normal power operation (LOW_POWER bit = 0 in the BW_RATE register, Address 0x2C) for self-test to operate correctly.
[7] Turn-on and wake-up times are determined by the user-defined bandwidth. At a 100 Hz data rate, the turn-on and wake-up times are each approximately 11.1 ms. For other data rates, the turn-on and wake-up times are each approximately τ + 1.1 in milliseconds, where τ = 1/(data rate).

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Acceleration	
Any Axis, Unpowered	10,000 *g*
Any Axis, Powered	10,000 *g*
V_S	−0.3 V to +3.9 V
$V_{DD\ I/O}$	−0.3 V to +3.9 V
Digital Pins	−0.3 V to $V_{DD\ I/O}$ + 0.3 V or 3.9 V, whichever is less
All Other Pins	−0.3 V to +3.9 V
Output Short-Circuit Duration (Any Pin to Ground)	Indefinite
Temperature Range	
Powered	−40°C to +105°C
Storage	−40°C to +105°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Table 3. Package Characteristics

Package Type	θ_{JA}	θ_{JC}	Device Weight
14-Terminal LGA	150°C/W	85°C/W	30 mg

PACKAGE INFORMATION

The information in Figure 2 and Table 4 provide details about the package branding for the ADXL345. For a complete listing of product availability, see the Ordering Guide section.

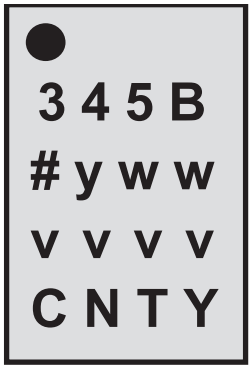

Figure 2. Product Information on Package (Top View)

Table 4. Package Branding Information

Branding Key	Field Description
345B	Part identifier for ADXL345
#	RoHS-compliant designation
yww	Date code
vvvv	Factory lot code
CNTY	Country of origin

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

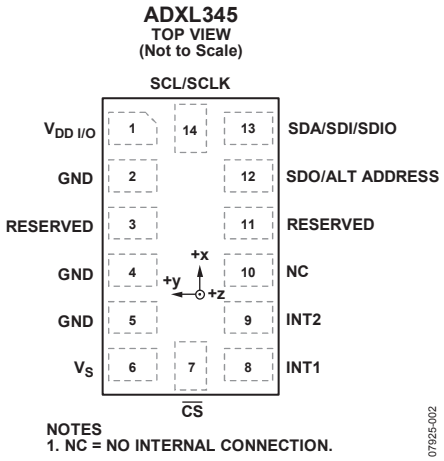

Figure 3. Pin Configuration (Top View)

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	$V_{DD\ I/O}$	Digital Interface Supply Voltage.
2	GND	This pin must be connected to ground.
3	RESERVED	Reserved. This pin must be connected to V_S or left open.
4	GND	This pin must be connected to ground.
5	GND	This pin must be connected to ground.
6	V_S	Supply Voltage.
7	$\overline{CS}$	Chip Select.
8	INT1	Interrupt 1 Output.
9	INT2	Interrupt 2 Output.
10	NC	Not Internally Connected.
11	RESERVED	Reserved. This pin must be connected to ground or left open.
12	SDO/ALT ADDRESS	Serial Data Output (SPI 4-Wire)/Alternate I^2C Address Select (I^2C).
13	SDA/SDI/SDIO	Serial Data (I^2C)/Serial Data Input (SPI 4-Wire)/Serial Data Input and Output (SPI 3-Wire).
14	SCL/SCLK	Serial Communications Clock. SCL is the clock for I^2C, and SCLK is the clock for SPI.

1.62. Induced draft fans (design characteristics)

- Number		2
- Manufacturer		VIM or EQUAL
- Type		Centrifugal
- Capacity per fan	Nm3/h	175 000
- Temperature	° C	150
- Static pressure	mm WG	220
- Fan speed	rpm	990
- Static efficiency	%	83.5
- Power consumption	kW	300
Characteristics of drive motor		
- Manufacturer		ALSTHOM or EQUAL
- Power / Volt / phase	kW/V/	355/6000/50 Hz
- Service Factor	%	Later
- Speed	rpm	990
- Efficiency at full load	%	93.1
- Power factor at full load	%	0.89
- Full load current	A	Later
- Locked rotor current	A	Later
- Insulation class		F
- Weight	kg	3 300

THE MODAL SHOP
AN MTS COMPANY

MODEL **9110D**

PORTABLE VIBRATION CALIBRATOR

- Create Calibration Certificates for Vibration Instrumentation
- Calibrate Vibration Analyzers & Meters In-House
- Confirm Critical Vibration Shutdown Alarms & Logic
- Detect Sensor Drift & Amplified Outputs at Key Frequencies
- Prevent Early or Late Shutdowns Due to Proximity Probe Errors
- Compliance to API 670 & ISO 9001

TYPICAL APPLICATIONS

- In-House Calibration of Vibration Instrumentation
- Safety Instrumented Systems (SIS)
- Loop Checks & System Troubleshooting, DCS & PLC
- Proximity Probe Testing and Checks for Mismatched Systems
- On-Turbine Vibration Sensors & Charge Amplifiers

LAB ACCURACY TO THE FIELD

The 9110D Portable Vibration Calibrator is the ideal tool for checking accelerometers, velocity transducers, and proximity probes over a wide operating frequency and amplitude range. The unit is a compact, battery-powered, and completely self-contained vibration reference source, which can be conveniently used to calibrate individual sensors, vibration switches, and data collectors, as well as to validate the entire measurement channel of a condition monitoring or recording system. An integral precision quartz reference accelerometer and closed-loop level control gives the 9110D enhanced stability and superior vibration calibration over an extended 5 Hz to 10 kHz frequency range. Packaged in a rugged Pelican® Storm case, the 9110D is always ready for travel to test sites, bringing laboratory accuracy to the field.

Additional features include an ICP®, voltage, charge mode or modulated current test sensor input for direct connection and readout of the most common types of accelerometers and velocity transducers. The test sensor sensitivity is calculated and displayed on the screen in real time. The unit's internal memory capability can store up to 500 calibration records, and data can be easily transferred to a computer through a USB flash drive. This allows for the creation and printing of ISO 17025-compliant, customizable calibration certificates and reports using the supplied Excel® workbook template. The workbook is also used to program repetitive tests into the calibrator along with pass/fail tolerances for each data point.

New CALROUTE firmware allows technicians to program repetitive calibration test points and pass/fail tolerances. Once programmed via supplied Microsoft Excel® workbook, technicians can perform calibrations rapidly and receive instant pass/fail feedback. No additional software is needed to program the calibrator or create reports.

CE

SPECIFICATIONS

Performance		
Frequency Range (operating) [1]	5 Hz to 10 kHz	300 to 600k CPM
Maximum Amplitude (50 Hz, 10-gram payload)	20 g pk	196 m/s² pk
	20 in/s pk	500 mm/s pk
	150 mils pk-pk	3.8 mm pk-pk
Maximum Amplitude (50 Hz, 500-gram payload)	2.5 g pk	24.5 m/s² pk
	3.5 in/s pk	90 mm/s pk
Maximum Payload [2]	800 grams	
Test Operation	Manual (Closed Loop) or Semi-Automatic	
Auto-Payload Calculation	Controlled via Reference Accelerometer, No User Entry Required	
Memory	Stores 500 Calibration Records; Stores 30 Data Points Per Calibration Record; Stores Model Number, Serial Number, Mounting Orientation & Notes for each Record; Stores Semi-Automated Test Routine	
Non-Volatile Memory	Up to 30 Test Points per Routine with Pass/Fail Upper & Lower Bound Tolerances	
Programmability	Manual (Closed Loop) or Semi-Automatic	
Accuracy of Readout [3]		
Acceleration (10 Hz to 10 kHz)	±3 % [4]	
Acceleration (5 Hz to 10 Hz)	±5 % [4]	
Velocity (10 Hz to 1000 Hz)	±3 %	
Displacement (30 Hz to 150 Hz)	±3 %	
Accuracy Verification Test	Field Drift Test Procedure Provided [5]	
Units of Readout		
Acceleration (pk and RMS)	g	m/s²
Velocity (pk and RMS)	in/s	mm/s
Displacement (pk to pk)	mils	µm
Frequency	Hz	CPM
Physical		
Sensor Under Test Sensitivity	mV/EU, mA/EU, µA/EU or pC/EU	
AC Power (for recharging battery)	110–240 VAC, 50–60 Hz	
Operating Battery Life [6]: 100 Hz, 1 g pk [1]	18 hours	
Sensor Under Test Input	ICP, Voltage, Modulated Current, Charge [7]	
Monitor Reference Out	10 mV/g (nominal) Quartz Reference Accelerometer, BNC Jack Output	
USB Port	Export Calibration Records to Flash Drive (FAT 32), Used for Loading Semi-Automated Test Routines (Model CALROUTE) & provides power for external power supplies	
Dimensions (H x W x D)	8.5 x 12 x 10 in	22 x 30.5 x 28 cm
Weight	18 lb	8.2 kg
Sensor Mounting Platform	¼-28 Thread Size	
Export File Format	CSV (comma-separated values)	

SPECIFICATIONS (continued)

Operating Temperature	32 °F–122 °F	0 °C–50 °C
Supplied Accessories [8]		
081B20	¼-28 to ¼-28 Adaptor	
081A08	10-32 to ¼-28 Adaptor	
M081A63	M8 x 1.25 M to ¼-28 M Mounting Stud	
PVC-MNT01	M8 x 1.25 F Thru Hole Mounting Pad	
081M165	M8 x 1 M to ¼-28 M Mounting Stud	
PVC-MNT02	M8 x 1 F Thru Hole Mounting Pad	
PVC-HTMNT01	Mounting Plate, 3- & 4-Hole High-Temp Vibration Sensors [10]	
PVC-HTMNT02	Mounting Plate, 3- & 4-Hole High-Temp Vibration Sensors [10]	
9100-CAL01	NIST Traceable Certificate of Calibration, Accredited to ISO 17025 by A2LA	
9110-USB	USB Flash Memory Drive: Loaded with Calibration Report Generation Workbook	
Calibration Report Generation Workbook	**Certificate Generated Via 9110D Memory:** Frequency Response & Linearity for AC Voltage Output Transducers **Certificate Generated Via User-Input:** Vibration analyzer/meter linearity & frequency response accuracy, linearity for 4-20 mA vibration transmitters, proximity probe curves (gap vs. DC voltage)	
Quickstart Guide	Available in English, Chinese, French, Japanese, Polish, Russian, & German	
Warranty	2 Years, Inclusive of Drift/Accuracy	
Tech Support	Training Webinars Available Upon Request, 24/7 Video Library	
Optional Accessories [8]		
9100-PPASH	Proximity probe adaptor kit for testing probes mounted inside a probe holder	
9155-MNT93	½-20 F to ¼-28 F Mounting	
9155-MNT43	¼" NPT F Mounting Adaptor to ¼-28 M	
9100-PPA01	Proximity probe adaptor kit for probes with 5 mm or 8 mm tip diameter [9]	
9100-HTCHRGKIT	High-temp charge mode accel calibration accessory kit	

Meets API 670 requirements for all required test points in acceleration or velocity from 10 Hz to 1000 Hz & payloads to 800 grams.

[1] 100-gram payload
[2] Operating range reduced at higher payloads. Reference manual for full details.
[3] Measured with 10-gram quartz reference accelerometer
[4] Calculated by measuring the % difference between the known sensitivity of a reference accelerometer as calibrated by laser primary system per ISO 16063-11 and the measured sensitivity of same reference accelerometer when tested at the same points
[5] Test is conducted independently of product firmware with calibrated voltmeter
[6] As shipped from factory in new condition
[7] External Charge Amplifier Required
[8] For a comprehensive list of available accessories, see Product Spec Sheet or call
[9] For metric unit micrometers, use Model 9100-MPPA01
[10] Mounting plates support sensors listed. Multi-hole mounting plates are convenient but not optimized for the best calibration results. The Modal Shop offers a full line of customized mounting pads validated in our calibration lab for precise results. Contact us for more information.

B&K: 8324
Bently Nevada: 330450, 330750, 350900
CEC: 4-123, 4-125, 4-126, 4-128, 4-130, 4-137, 4-138, 4-170, 4-171
Dytran: 3085C and 3235 series
Endevco: 6233C, 6222M, 6222S, and 6240 Series
Metrix: 5485C, SA6350
PCB Piezotronics: 357 & EX600B series, EX615A42 and EX619A11
Vibro-Meter: CA 134, CE 134, CA 202, CA 280, CE 281, CA 303, CA 306, CE 311

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The Modal Shop, Inc. offers structural vibration and acoustic sensing systems and services for various applications in design and test laboratories as well as manufacturing plants. An extensive sound and vibration rental program, precision calibration systems, and both modal and vibration shakers are designed to simplify test phases. Non Destructive Testing Systems help manufacturers provide 100% quality inspection of metal components. The Modal Shop, Inc. is a subsidiary of PCB Piezotronics, Inc., and PCB® is a wholly owned subsidiary of MTS Systems Corporation.

DS-0103 revF

MTS SENSORS

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