LAMPIRAN-LAMPIRAN

Lampiran 1.

Datasheet STM32F4 *Discovery*

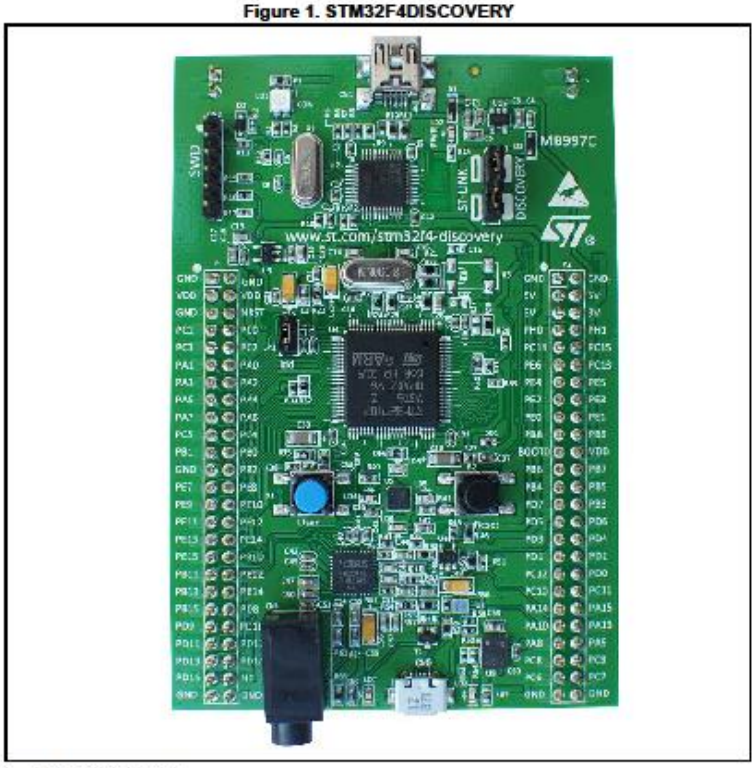
UM1472
User manual

Discovery kit for STM32F407/417 lines

Introduction

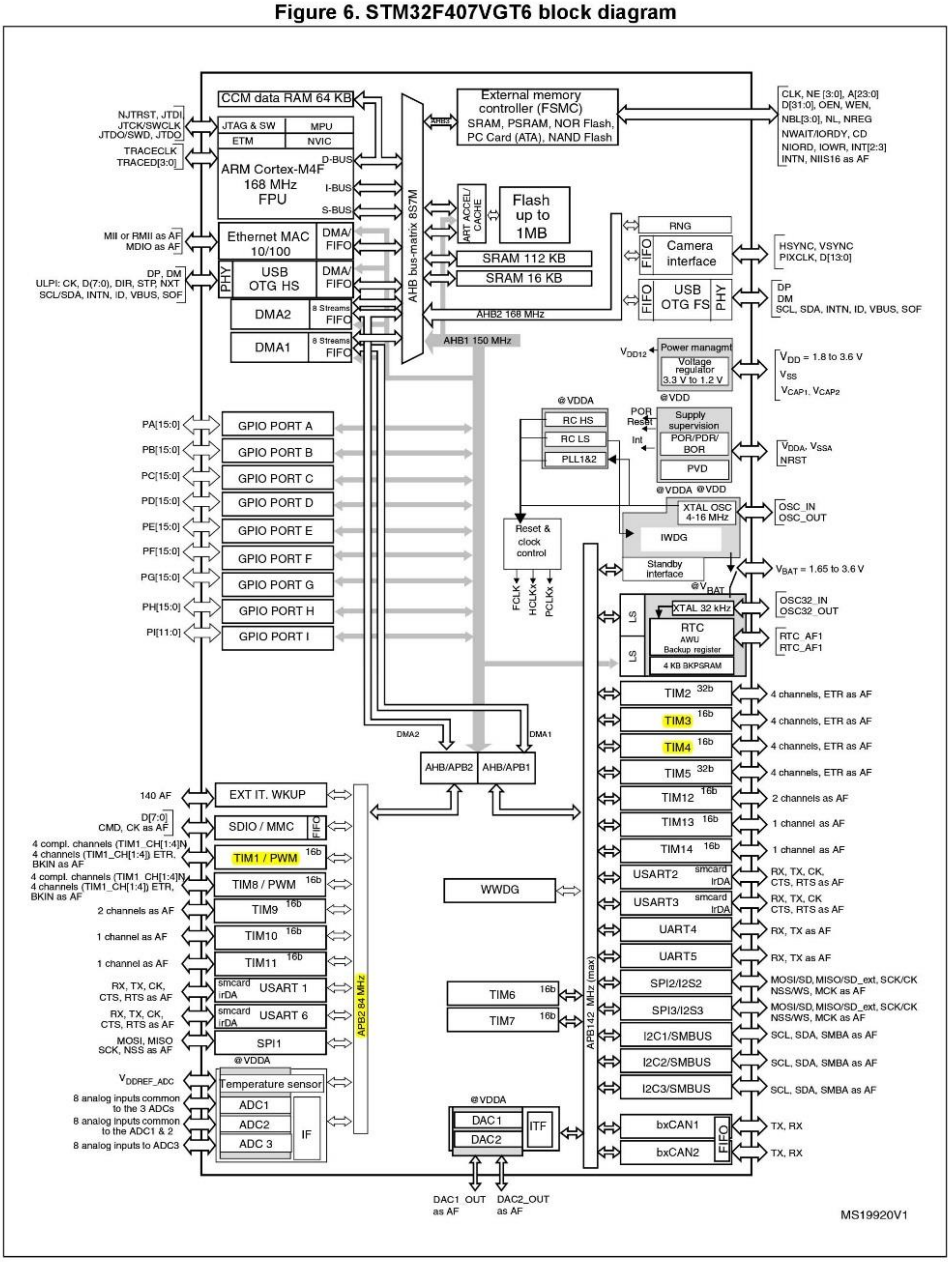
The STM32F4DISCOVERY helps you to discover the STM32F407 & STM32F417 lines' high-performance features and to develop your applications.
It is based on an STM32F407VGT6 and includes an ST-LINK/V2 embedded debug tool interface, ST MEMS digital accelerometer, ST MEMS digital microphone, audio DAC with integrated class D speaker driver, LEDs, pushbuttons and a USB OTG micro-AB connector.

Figure 1. STM32F4DISCOVERY



1. Picture not contractual

Figure 6. STM32F407VGT6 block diagram

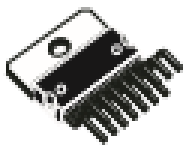


Lampiran 2.
Datasheet *Driver* L298

L298

DUAL FULL-BRIDGE DRIVER

- OPERATING SUPPLY VOLTAGE UP TO 46 V
- TOTAL DC CURRENT UP TO 4 A
- LOW SATURATION VOLTAGE
- OVERTEMPERATURE PROTECTION
- LOGICAL "0" INPUT VOLTAGE UP TO 1.5 V (HIGH NOISE IMMUNITY)

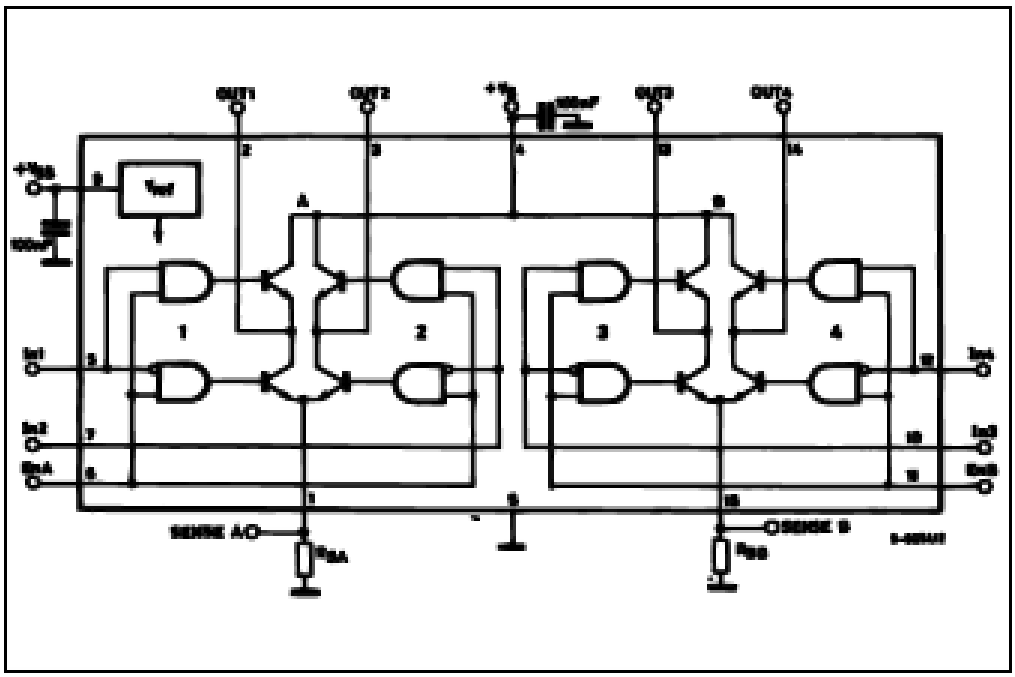


ORDERING NUMBERS : L298N (Multiwatt Vert.)
L298HN (Multiwatt Horiz.)
L298P (PowerSO20)

DESCRIPTION

The L298 is an integrated monolithic circuit in a 15-lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.

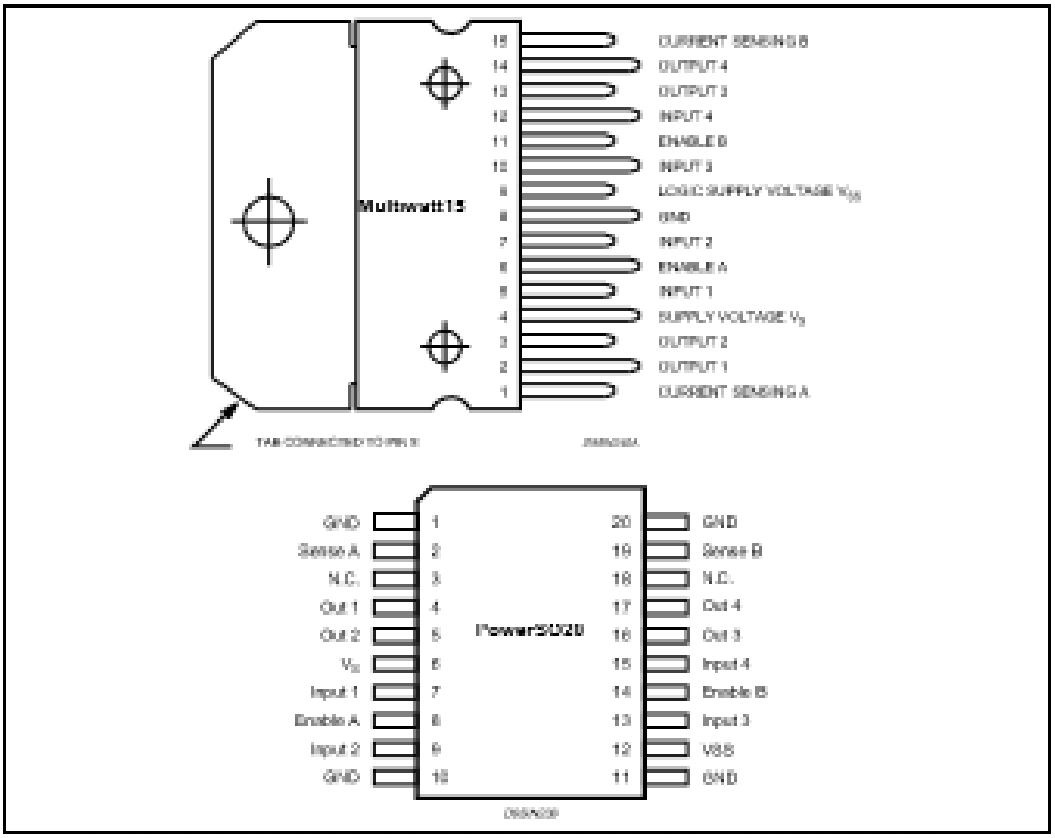
BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Power Supply	50	V
V_{SS}	Logic Supply Voltage	7	V
V_i, V_{en}	Input and Enable Voltage	–0.3 to 7	V
I_O	Peak Output Current (each Channel) – Non Repetitive (t = 100μs) –Repetitive (80% on –20% off; t_{on} = 10ms) –DC Operation	 3 2.5 2	 A A A
V_{sens}	Sensing Voltage	–1 to 2.3	V
P_{tot}	Total Power Dissipation (T_{case} = 75°C)	25	W
T_{op}	Junction Operating Temperature	–25 to 130	°C
T_{stg}, T_j	Storage and Junction Temperature	–40 to 150	°C

PIN CONNECTIONS (top view)



THERMAL DATA

Symbol	Parameter		PowerSO20	Multiwatt15	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max.	–	3	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	13 (*)	35	°C/W

(*) Mounted on aluminum substrate

PIN FUNCTIONS (refer to the block diagram)

MW.15	PowerSO	Name	Function
1;15	2;19	Sense A; Sense B	Between this pin and ground is connected the sense resistor to control the current of the load.
2;3	4;5	Out 1; Out 2	Outputs of the Bridge A; the current that flows through the load connected between these two pins is monitored at pin 1.
4	6	V_S	Supply Voltage for the Power Output Stages. A non-inductive 100nF capacitor must be connected between this pin and ground.
5;7	7;9	Input 1; Input 2	TTL Compatible Inputs of the Bridge A.
6;11	8;14	Enable A; Enable B	TTL Compatible Enable Input: the L state disables the bridge A (enable A) and/or the bridge B (enable B).
8	1,10,11,20	GND	Ground.
9	12	V_{SS}	Supply Voltage for the Logic Blocks. A100nF capacitor must be connected between this pin and ground.
10; 12	13;15	Input 3; Input 4	TTL Compatible Inputs of the Bridge B.
13; 14	16;17	Out 3; Out 4	Outputs of the Bridge B. The current that flows through the load connected between these two pins is monitored at pin 15.
–	3;18	N.C.	Not Connected

ELECTRICAL CHARACTERISTICS (V_S = 42V; V_{SS} = 5V, T_j = 25°C; unless otherwise specified)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
V_S	Supply Voltage (pin 4)	Operative Condition		V_{IH} +2.5		46	V
V_{SS}	Logic Supply Voltage (pin 9)			4.5	5	7	V
I_S	Quiescent Supply Current (pin 4)	V_{en} = H; I_L = 0	V_i = L V_i = H		13 50	22 70	mA mA
		V_{en} = L	V_i = X			4	mA
I_{SS}	Quiescent Current from V_{SS} (pin 9)	V_{en} = H; I_L = 0	V_i = L V_i = H		24 7	36 12	mA mA
		V_{en} = L	V_i = X			6	mA
V_{IL}	Input Low Voltage (pins 5, 7, 10, 12)			−0.3		1.5	V
V_{IH}	Input High Voltage (pins 5, 7, 10, 12)			2.3		V_{SS}	V
I_{IL}	Low Voltage Input Current (pins 5, 7, 10, 12)	V_i = L				−10	µA
I_{IH}	High Voltage Input Current (pins 5, 7, 10, 12)	V_i = H ≤ V_{SS} −0.6V			30	100	µA
V_{en} = L	Enable Low Voltage (pins 6, 11)			−0.3		1.5	V
V_{en} = H	Enable High Voltage (pins 6, 11)			2.3		V_{SS}	V
I_{en} = L	Low Voltage Enable Current (pins 6, 11)	V_{en} = L				−10	µA
I_{en} = H	High Voltage Enable Current (pins 6, 11)	V_{en} = H ≤ V_{SS} −0.6V			30	100	µA
$V_{CE(sat)(H)}$	Source Saturation Voltage	I_L = 1A I_L = 2A		0.95	1.35 2	1.7 2.7	V V
$V_{CE(sat)(L)}$	Sink Saturation Voltage	I_L = 1A (5) I_L = 2A (5)		0.85	1.2 1.7	1.6 2.3	V V
$V_{CE(sat)}$	Total Drop	I_L = 1A (5) I_L = 2A (5)		1.80		3.2 4.9	V V
V_{sens}	Sensing Voltage (pins 1, 15)			−1 (1)		2	V

Lampiran 3.
Datasheet Sensor KTY10-6

Infineon technologies

Silicon Temperature Sensors

KT 100	KTY 10-x
KT 110	KTY 11-x
KT 130	KTY 13-x
KT 210	KTY 21-x
KT 230	KTY 23-x
KTY 16-6	KTY 19-6

Features

- Temperature dependent resistor with positive temperature coefficient
- Temperature range – 50 °C to + 150 °C (– 60 F to 300 F)
- Available in SMD or leaded or customized packages
- Linear output
- Excellent longterm stability
- Polarity independent due to symmetrical construction
- Fast response time
- Resistance tolerances (R_{25}) of ± 3% or ± 1%

Modified TO-92

TO-92 Mini

SOT-23

KTY 16-6

KTY 19-6

Standard Packages

Type	Marking	Ordering Code	$R_{25\,min}$	$R_{25\,max}$	Package
			(in Ω with I_{op} = 1 mA)		
KT 100	KT 100	Q62705-K331	1940	2060	TO-92
KT 110	T1	Q62705-K332	1940	2060	TO-92 Mini
KT 130	T1	Q62705-K333	1940	2060	SOT-23
KT 210	N1	Q62705-K334	970	1030	TO-92 Mini
KT 230	N1	Q62705-K335	970	1030	SOT-23
KTY 10-5	KTY 10-5	Q62705-K110	1950	1990	TO-92
KTY 10-6	KTY 10-6	Q62705-K132	1980	2020	TO-92
KTY 10-62	KTY 10-62	Q62705-K71	1990	2010	TO-92
KTY 10-7	KTY 10-7	Q62705-K111	2010	2050	TO-92
KTY 11-5	T5	Q62705-K245	1950	1990	TO-92 Mini
KTY 11-6	T6	Q62705-K246	1980	2020	TO-92 Mini
KTY 11-7	T7	Q62705-K247	2010	2050	TO-92 Mini
KTY 13-5	T5	Q62705-K249	1950	1990	SOT-23
KTY 13-6	T6	Q62705-K250	1980	2020	SOT-23
KTY 13-7	T7	Q62705-K251	2010	2050	SOT-23
KTY 21-5	N5	Q62705-K258	975	995	TO-92 Mini
KTY 21-6	N6	Q62705-K259	990	1010	TO-92 Mini
KTY 21-7	N7	Q62705-K260	1005	1025	TO-92 Mini
KTY 23-5	N5	Q62705-K262	975	995	SOT-23
KTY 23-6	N6	Q62705-K263	990	1010	SOT-23
KTY 23-7	N7	Q62705-K264	1005	1025	SOT-23

Custom Packages

Type	Marking	Ordering Code	$R_{25\,min}$	$R_{25\,max}$	Screw Thread
			(in Ω with I_{op} = 1 mA)		
KTY 16-6	none	Q62705-K128	1980	2020	–
KTY 19-6M	KTY 19M	Q62705-K271	1980	2020	ISO M10x1
KTY 19-6Z	KTY 19Z	Q62705-K272	1980	2020	NPTF 1/8x27
Connector set for KTY 19		Q62901-B80			

Absolute Maximum Ratings

Parameter	Symbol	KT 1x0 KTY 1x-x	KT 2x0 KTY 2x-x	Unit
Maximum operating voltage [1] $T_A \leq 25$ °C, $t \leq 10$ ms	V_{opmax}	25		V
Maximum operating current	I_{opmax}	5	7	mA
Peak operating current $T_A \leq 25$ °C, $t \leq 10$ ms	I_{opp}	7	10	mA
Operating temperature range	T_{op}	– 50 ... + 150		°C
Storage temperature range	T_{stg}	– 50 ... + 150		°C

[1] ESD Class 1. When the temperature sensor is operated with long supply leads, it should be protected through the parallel connection of a > 10 nF capacitor to prevent damage to the sensor through induced voltage peaks.

Electrical Characteristics

I_{op} = 1 mA

Thermal Time Constant (τ); (63% of ΔT)	$\tau_{air\ (typ.)}$	$\tau_{oil\ (typ.)}$	Unit
KT 100, KTY 10-x	40	4	s
KT 110, KT 210, KTY 11-x, KTY 21-x	11	1.5	
KT 130, KT 230, KTY 13-x, KTY 23-x	7	1	
KTY 16-6	40	4	
KTY 19-6M/Z	40	4	

Lampiran 4.
Main Program

```
#include "stm32f4xx.h"
#include "stm32f4xx_tim.h"
#include "stm32f4xx_gpio.h"
#include "stm32f4xx_rcc.h"
#include "stm32f4xx_adc.h"
#include "stm32f4xx_syscfg.h"
#include "stm32f4xx_usart.h"
#include "misc.h"
#include  "TEUB_USART.h"
#include "TEUB_GPIO.h"

#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdarg.h>

/***Pin IO***/
#define P_0  GPIO_Pin_0
#define P_1  GPIO_Pin_1
#define P_2  GPIO_Pin_2
#define P_3  GPIO_Pin_3
#define P_4  GPIO_Pin_4
#define P_5  GPIO_Pin_5
#define P_6  GPIO_Pin_6
#define P_7  GPIO_Pin_7
#define P_8  GPIO_Pin_8
#define P_9  GPIO_Pin_9
#define P_10  GPIO_Pin_10
#define P_11  GPIO_Pin_11
#define P_12  GPIO_Pin_12
#define P_13  GPIO_Pin_13
#define P_14  GPIO_Pin_14
#define P_15  GPIO_Pin_15

/***Parameter awal***/
#define KP 55.4
#define KI 44.2
#define KD 37.25
#define SP 3.6

/***PWM PRESCALER***/
#define   PWM_TIM5_PERIODE    1000                        // periode   (100
dutycycle)
#define   PWM_TIM5_PRESCALE   420                         // prescaler (839
=> 1kHz)
#define   PWM_TIM5_POLARITY   TIM_OCPolarity_High

/***PWM CCR***/
#define   PWM_1R TIM5->CCR1

/***Set variables used***/
GPIO_InitTypeDef              GPIO_InitStructure;
NVIC_InitTypeDef              NVIC_InitStructure;
USART_InitTypeDef             USART_InitStructure;
TIM_TimeBaseInitTypeDef       TIM_TimeBaseStructure;
TIM_OCInitTypeDef             TIM_OCInitStructure;
ADC_InitTypeDef               ADC_init_structure;

/***Setting up Variable ADC and USART***/
```

```
char usart_sign = 'f';
char str_usart[5];

/***Setting up Variable PID***/
float error = 0;float derror = 0;float error_1 = 0;float error_2 = 0;
float action = 0;float action_1 = 0; float action_2 = 0;

/*function General*/
void setting_ADC();
int  adc_convert();
void TIM5_init();
void setting_GPIO_Driver();
void set_NVIC_USART();
int toInt(char a, char b, char c, char d);
float getSuhu(int x);
float getError(float x);
float getDerror(float x);

/*function PID*/
float PID_calculate(float setpoint, float kp, float ki, float kd, float
error);

int main(void)
{
      init_USART(RCC_APB1Periph_USART2, 9600, RCC_AHB1Periph_GPIOD, P_5|P_6,
TX_RX);
      Delayms(100);
      set_NVIC_USART();
      setting_GPIO_Driver();
      setting_ADC();
      TIM5_init();
   while(1)
   {
      if(usart_sign == 'a'){
            int adc;
            float Suhu, Error, Derror, Control_Action;
            adc = adc_convert();
            Suhu = getSuhu(adc);
            Error = getError(Suhu, SP);
            Derror = getDerror(Error, error_1);
            Control_Action = PID_calculate(SP,KP,KI,KD,Error);
            PWM_1R = Control_Action;
            cetak(USART2, "%c", Suhu);
      }
      else{
            PWM_1R = 0;
            set_all_param_zero();
            cnt = 0;
      }
   }
}

/***General Function***/
void setting_ADC(){
      RCC_APB2PeriphClockCmd(RCC_APB2Periph_ADC1,ENABLE);
      RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOA, ENABLE);
      //RCC_AHB1PeriphClockCmd(RCC_AHB1ENR_GPIOAEN, ENABLE);

      GPIO_InitStructure.GPIO_Pin = P_1;
      GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AN;
```

```
	GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
	GPIO_Init(GPIOA, &GPIO_InitStructure);

	ADC_DeInit();
	ADC_init_structure.ADC_DataAlign = ADC_DataAlign_Right;
	ADC_init_structure.ADC_Resolution = ADC_Resolution_12b;
	ADC_init_structure.ADC_ContinuousConvMode = ENABLE;
	ADC_init_structure.ADC_ExternalTrigConv = ADC_ExternalTrigConv_T1_CC1;
	ADC_init_structure.ADC_ExternalTrigConvEdge =
ADC_ExternalTrigConvEdge_None;
	ADC_init_structure.ADC_NbrOfConversion = 1;
	ADC_init_structure.ADC_ScanConvMode = DISABLE;
	ADC_Init(ADC1,&ADC_init_structure);

	ADC_RegularChannelConfig(ADC1,ADC_Channel_1,1,ADC_SampleTime_480Cycles)
;
	ADC_Cmd(ADC1,ENABLE);
}
int adc_convert(){
	ADC_SoftwareStartConv(ADC1);//Start the conversion
	while(!ADC_GetFlagStatus(ADC1, ADC_FLAG_EOC));//Processing the
conversion
	return ADC_GetConversionValue(ADC1); //Return the converted data
}
float getSuhu(int x)
{
	float suhu;
	suhu = x * 0.00144;
	return suhu;
}
float getError(float e, float sp)
{
	float error_;
	error_ = sp - e;
	return error_;
}
float getDerror(float e, float e_1)
{
	float dError_;
	dError_ = e - e_1;
	return dError_;
}
void TIM5_init()
{
	// Clock enable
	RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOA, ENABLE);		// Clocking
GPIOC (AHB1/APB1 = 42MHz)
	RCC_APB1PeriphClockCmd(RCC_APB1Periph_TIM5, ENABLE);		// Clocking
TIM3  (APB1 = 42x2PLL=84MHz)

	// GPIO__TIM_init
	GPIO_InitStructure.GPIO_Pin   = P_0;				// Ch.1
(PC6), Ch.2 (PC7)
	GPIO_InitStructure.GPIO_Mode  = GPIO_Mode_AF;			// PWM is an
alternative function
	GPIO_InitStructure.GPIO_Speed = GPIO_Speed_2MHz;		//
GPIO_HIGH_Speed
	GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;			// Push-pull
	GPIO_InitStructure.GPIO_PuPd  = GPIO_PuPd_NOPULL;
```

```
	GPIO_Init(GPIOA, &GPIO_InitStructure);
// Initializing GPIOC structure
	GPIO_PinAFConfig(GPIOA, GPIO_PinSource0, GPIO_AF_TIM5);	// Routing
TIM3 output to PC6

	// Timer init
	TIM_TimeBaseStructure.TIM_ClockDivision = TIM_CKD_DIV1;
// => 0 = Not dividing
	TIM_TimeBaseStructure.TIM_CounterMode	= TIM_CounterMode_Up;
// Upcounting configuration
	TIM_TimeBaseStructure.TIM_Period	= PWM_TIM5_PERIODE;
// Autoreload value (ARR)
	TIM_TimeBaseStructure.TIM_Prescaler	= PWM_TIM5_PRESCALE;
// Pembagi Timclock, prescale=>328, Timclock=>84MHz ====> 84Mhz/255/328=
mendekati 1kHz
	TIM_TimeBaseInit(TIM5, &TIM_TimeBaseStructure);
// Initializing Time Base structure

	// Channel 1, Ch.1 (PC6)
	TIM_OCInitStructure.TIM_OCMode	= TIM_OCMode_PWM1;
// PWM mode 1 = Set on compare match, PWM mode 2 = Clear on compare match
pasangan OCPolarity_LOW
	TIM_OCInitStructure.TIM_OutputState = TIM_OutputState_Enable;
// Enabling the Output Compare state
	TIM_OCInitStructure.TIM_OCPolarity  = PWM_TIM5_POLARITY;
// Regular polarity (low will inverse it)
	//if (PWM_R>PWM_TIM3_PERIODE) {PWM_R=PWM_TIM3_PERIODE;}
	TIM_OCInitStructure.TIM_Pulse	= PWM_1R;
		// Output Compare 1 reg value>>>diberi nilai PWM
	TIM_OC1Init(TIM5, &TIM_OCInitStructure);
// Initializing Output Compare 1 structure
	TIM_OC1PreloadConfig(TIM5, TIM_OCPreload_Enable);
// Enable Ch.1 Output Compare preload

	// Timer enable
	TIM_Cmd(TIM5, ENABLE);
}
void setting_GPIO_Driver()
{
	RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOD,ENABLE);
	GPIO_InitStructure.GPIO_Pin = P_1 | P_2;
	GPIO_InitStructure.GPIO_Mode = GPIO_Mode_OUT;
	GPIO_InitStructure.GPIO_Speed = GPIO_Speed_25MHz;
	GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;
	GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
	GPIO_Init(GPIOD, &GPIO_InitStructure);
	GPIO_SetBits(GPIOD, P_2);
	GPIO_ResetBits(GPIOD, P_1);
}
void set_NVIC_USART()
{
    NVIC_InitStructure.NVIC_IRQChannel = USART2_IRQn;		// we want to
configure the USART2 interrupts
    NVIC_InitStructure.NVIC_IRQChannelPreemptionPriority = 0;// this sets the
priority group of the USART2 interrupts
    NVIC_InitStructure.NVIC_IRQChannelSubPriority = 0;		// this sets the
subpriority inside the group
    NVIC_InitStructure.NVIC_IRQChannelCmd = ENABLE;		// the USART1
interrupts are globally enabled
```

```
    NVIC_Init(&NVIC_InitStructure);                    // the properties
are passed to the NVIC_Init function which takes care of the low level stuff
}


void USART2_IRQHandler()
{
      if( USART_GetITStatus(USART2, USART_IT_RXNE) ){
            char x = USART2->DR;
            if(x == 'a'){usart_sign = 'a';}
            else{usart_sign = 'f';}
      }
}

/***PID Function***/
float PID_calculate(float setpoint, float kp, float ki, float kd, float
error){
        float PID_result;
        PID_result = action_2+(kp*(error-
error_1))+((ki*0.5)*(error+(2*error_1)+error_2))+
                    ((kd*2)*(error-(2*error_1)+error_2));
        error_2 = error_1;error_1 = error;
        action_2 = action_1;action_1 = action;
        return PID_result;
}
```

Lampiran 5.
Data Pengujian

No	3V	3V+ Gangguan	3.2	3.2+ Gangguan	3.4	3.6	3.8	4
0	2.52	2.49	2.48	2.51	2.51	2.51	2.51	2.52
1	2.55	2.52	2.39	2.5	2.48	2.5	2.47	2.51
2	2.47	2.51	2.5	2.51	2.54	2.53	2.48	2.56
3	2.57	2.51	2.49	2.51	2.52	2.51	2.45	2.54
4	2.53	2.47	2.49	2.55	2.54	2.53	2.5	2.61
5	2.57	2.51	2.47	2.53	2.55	2.54	2.52	2.54
6	2.56	2.54	2.51	2.53	2.55	2.56	2.54	2.55
7	2.56	2.53	2.53	2.53	2.57	2.55	2.5	2.56
8	2.57	2.56	2.53	2.56	2.53	2.62	2.54	2.55
9	2.58	2.55	2.55	2.57	2.55	2.56	2.55	2.6
10	2.61	2.55	2.57	2.52	2.66	2.56	2.58	2.61
11	2.62	2.56	2.56	2.59	2.59	2.59	2.57	2.62
12	2.64	2.58	2.6	2.58	2.69	2.59	2.61	2.63
13	2.65	2.57	2.6	2.56	2.64	2.63	2.61	2.65
14	2.63	2.59	2.62	2.64	2.64	2.65	2.63	2.68
15	2.71	2.65	2.62	2.62	2.68	2.66	2.65	2.71
16	2.66	2.58	2.63	2.67	2.68	2.66	2.67	2.71
17	2.7	2.62	2.66	2.65	2.7	2.76	2.7	2.73
18	2.7	2.65	2.68	2.71	2.7	2.74	2.73	2.75
19	2.72	2.65	2.68	2.68	2.73	2.73	2.72	2.8
20	2.75	2.67	2.7	2.73	2.76	2.75	2.77	2.82
21	2.75	2.7	2.75	2.73	2.74	2.77	2.71	2.86
22	2.77	2.71	2.75	2.8	2.78	2.79	2.79	2.86
23	2.79	2.71	2.8	2.76	2.84	2.85	2.84	2.9
24	2.8	2.71	2.8	2.77	2.84	2.85	2.85	2.9
25	2.76	2.72	2.8	2.7	2.88	2.86	2.89	2.95
26	2.83	2.73	2.84	2.8	2.89	2.87	2.91	2.96
27	2.85	2.79	2.86	2.8	2.9	2.9	2.98	3
28	2.87	2.75	2.89	2.83	2.93	2.92	2.94	3.02
29	2.89	2.77	2.89	2.83	2.93	2.92	2.97	3.06
30	2.92	2.81	2.92	2.85	2.97	3.02	3.02	3.04
31	2.91	2.78	2.94	2.85	3	2.97	3.15	3.08
32	2.95	2.83	2.97	2.87	3.02	2.99	3.1	3.13
33	2.92	2.81	2.98	2.9	3.02	3.09	3.07	3.19
34	2.98	2.81	3	2.91	3.05	3.07	3.09	3.16
35	3	2.92	3.02	2.9	3.1	3.05	3.13	3.2
36	2.98	2.87	3.05	2.96	3.11	3.1	3.15	3.23
37	3.03	2.87	3.04	2.93	3.07	3.11	3.2	3.27

38	3.06	2.87	3.05	2.96	3.11	3.16	3.2	3.22
39	3.06	2.89	3.12	2.94	3.17	3.13	3.21	3.32
40	3.1	2.93	3.13	2.97	3.16	3.22	3.24	3.32
41	3.15	2.91	3.15	2.98	3.21	3.23	3.26	3.36
42	3.1	2.92	3.16	2.99	3.22	3.23	3.3	3.37
43	3.1	2.93	3.19	3	3.23	3.25	3.33	3.39
44	3.12	2.93	3.17	3.02	3.31	3.26	3.34	3.42
45	3.12	2.97	3.21	3.01	3.27	3.29	3.41	3.45
46	3.14	2.97	3.24	3.05	3.29	3.29	3.37	3.45
47	3.13	2.97	3.27	3.05	3.35	3.32	3.41	3.55
48	3.12	2.98	3.28	3.07	3.31	3.33	3.42	3.52
49	3.12	2.99	3.27	3.04	3.36	3.36	3.45	3.53
50	3.13	2.93	3.29	3.07	3.38	3.36	3.49	3.61
51	3.12	3.01	3.29	3.05	3.39	3.38	3.49	3.63
52	3.16	2.98	3.31	3.08	3.41	3.4	3.51	3.55
53	3.15	3.01	3.33	3.07	3.37	3.43	3.51	3.69
54	3.1	3.01	3.37	3.05	3.46	3.42	3.54	3.64
55	3.15	3.03	3.33	3.1	3.45	3.46	3.56	3.68
56	3.15	3.02	3.34	3.09	3.47	3.45	3.57	3.7
57	3.15	3.03	3.35	3.11	3.48	3.5	3.6	3.7
58	3.14	3.03	3.35	3.12	3.5	3.51	3.64	3.72
59	3.1	3.02	3.36	3.12	3.5	3.52	3.62	3.75
60	3.17	3.02	3.34	3.17	3.49	3.54	3.69	3.77
61	3.15	2.99	3.35	3.17	3.52	3.54	3.68	3.79
62	3.14	3.02	3.34	3.14	3.52	3.55	3.7	3.8
63	3.13	3.03	3.34	3.1	3.52	3.58	3.71	3.8
64	3.13	3.03	3.32	3.14	3.49	3.58	3.74	3.85
65	3.1	3	3.34	3.15	3.54	3.63	3.74	3.88
66	3.13	3	3.35	3.17	3.52	3.63	3.77	3.86
67	3.13	3	3.34	3.12	3.52	3.63	3.77	3.88
68	3.12	3.01	3.34	3.16	3.52	3.65	3.74	3.89
69	3.11	2.98	3.33	3.11	3.53	3.64	3.79	3.98
70	3.11	3	3.3	3.19	3.46	3.66	3.81	3.9
71	3.12	3	3.3	3.21	3.52	3.67	3.83	3.97
72	3.11	2.98	3.32	3.2	3.53	3.69	3.86	3.96
73	3.09	2.98	3.27	3.19	3.54	3.69	3.79	3.97
74	3.09	2.96	3.3	3.19	3.5	3.71	3.83	4.01
75	3.08	2.96	3.29	3.16	3.5	3.63	3.88	3.98
76	3.12	3.01	3.3	3.18	3.51	3.67	3.86	4
77	3.07	2.96	3.29	3.26	3.49	3.68	3.82	4.02
78	3.08	2.94	3.27	3.18	3.49	3.65	3.88	3.97
79	3.06	2.95	3.28	3.14	3.47	3.67	3.86	4.01
80	3.03	2.94	3.26	3.17	3.46	3.64	3.87	4.02

81	3.05	2.92	3.22	3.17	3.43	3.62	3.88	4.02
82	3.03	2.94	3.21	3.17	3.45	3.67	3.87	4.03
83	3.04	2.97	3.24	3.17	3.44	3.69	3.87	4.03
84	3.05	3.01	3.22	3.19	3.43	3.64	3.8	4.03
85	3.01	2.95	3.2	3.16	3.4	3.63	3.8	4.02
86	3.02	2.95	3.19	3.15	3.41	3.61	3.85	4
87	3.01	2.95	3.19	3.09	3.4	3.59	3.8	3.97
88	3.01	2.97	3.17	3.14	3.42	3.66	3.84	4.03
89	3.01	2.96	3.17	3.17	3.39	3.62	3.79	4.01
90	3.01	2.97	3.15	3.15	3.36	3.57	3.85	4
91	3	2.97	3.17	3.16	3.39	3.58	3.73	4
92	3	3.02	3.17	3.15	3.33	3.56	3.79	4
93	2.98	2.96	3.17	3.14	3.35	3.52	3.79	3.95
94	2.99	3	3.16	3.15	3.32	3.54	3.78	3.94
95	2.98	2.98	3.14	3.17	3.26	3.53	3.77	3.95
96	2.99	2.94	3.15	3.16	3.31	3.53	3.77	3.9
97	2.95	2.98	3.16	3.14	3.32	3.53	3.68	3.93
98	2.96	3.01	3.15	3.16	3.31	3.53	3.75	3.96
99	2.94	3.01	3.13	3.18	3.39	3.52	3.75	3.93
100	2.97	3.01	3.15	3.18	3.36	3.52	3.74	3.9
101	2.95	3	3.16	3.15	3.3	3.51	3.72	3.91
102	2.98	2.99	3.16	3.13	3.31	3.51	3.72	3.86
103	2.94	3.01	3.15	3.18	3.27	3.53	3.73	3.91
104	2.95	3.01	3.18	3.19	3.31	3.5	3.7	3.89
105	2.94	2.95	3.15	3.16	3.33	3.53	3.71	3.93
106	3	3.01	3.17	3.18	3.29	3.55	3.72	3.89
107	2.96	3.01	3.21	3.16	3.31	3.57	3.65	3.89
108	2.96	3.03	3.19	3.18	3.33	3.55	3.72	3.93
109	2.95	3.02	3.2	3.18	3.33	3.52	3.73	3.89
110	2.97	2.99	3.21	3.15	3.34	3.54	3.72	3.89
111	2.97	3.04	3.24	3.2	3.37	3.54	3.71	3.91
112	2.96	2.98	3.22	3.22	3.36	3.55	3.76	3.93
113	2.98	2.98	3.25	3.21	3.36	3.56	3.73	3.93
114	2.96	3	3.24	3.25	3.38	3.57	3.75	3.93
115	2.97	2.99	3.26	3.2	3.38	3.55	3.72	3.9
116	3.01	3	3.24	3.15	3.41	3.59	3.74	3.92
117	3	2.98	3.25	3.19	3.4	3.59	3.78	3.95
118	2.99	3.02	3.28	3.18	3.44	3.61	3.78	3.98
119	3.06	2.98	3.27	3.2	3.43	3.6	3.77	3.98
120	3.01	2.97	3.27	3.18	3.44	3.63	3.81	3.97
121	3.01	2.97	3.26	3.19	3.42	3.65	3.78	4.01
122	3.02	2.98	3.27	3.19	3.45	3.62	3.8	4.01
123	3.04	2.99	3.27	3.2	3.47	3.65	3.75	3.96

124	3.02	2.98	3.27	3.18	3.47	3.64	3.81	4.02
125	3.05	2.98	3.26	3.21	3.46	3.63	3.83	4.03
126	3.05	2.99	3.24	3.2	3.49	3.68	3.83	4.04
127	3.06	2.96	3.26	3.18	3.48	3.62	3.82	4.03
128	3.06	2.95	3.24	3.18	3.49	3.64	3.74	4.06
129	3.06	3.01	3.25	3.14	3.49	3.64	3.8	4.05
130	3.06	2.96	3.26	3.16	3.47	3.63	3.83	4.03
131	3.06	2.97	3.23	3.16	3.5	3.65	3.84	3.98
132	3.06	2.94	3.23	3.16	3.48	3.63	3.8	4.04
133	3.06	2.92	3.23	3.18	3.47	3.63	3.84	4.06
134	3.07	2.93	3.19	3.17	3.45	3.6	3.78	4.04
135	3.09	2.94	3.23	3.18	3.46	3.62	3.83	4.04
136	3.04	2.95	3.21	3.16	3.47	3.6	3.85	4.02
137	3.06	2.96	3.18	3.17	3.46	3.67	3.86	4.02
138	3.07	2.96	3.22	3.13	3.45	3.56	3.82	4.02
139	3.07	2.96	3.2	3.18	3.45	3.58	3.83	3.98
140	3.09	2.98	3.17	3.15	3.45	3.58	3.81	3.98
141	3.06	2.96	3.21	3.17	3.46	3.57	3.82	3.97
142	3.07	2.96	3.19	3.17	3.45	3.56	3.76	3.97
143	2.98	2.98	3.19	3.19	3.44	3.54	3.83	3.95
144	3.07	2.97	3.14	3.16	3.4	3.57	3.84	3.94
145	3.06	2.94	3.17	3.24	3.42	3.53	3.81	3.94
146	3.08	2.99	3.15	3.17	3.43	3.54	3.82	3.95
147	3.05	2.99	3.17	3.2	3.43	3.51	3.8	3.92
148	3.05	2.99	3.19	3.18	3.42	3.55	3.81	3.92
149	3.06	3	3.14	3.17	3.41	3.53	3.77	3.91
150	3.04	2.99	3.17	3.17	3.39	3.52	3.8	3.92
151	3.04	3.01	3.17	3.15	3.38	3.54	3.74	3.92
152	3.03	3.02	3.16	3.16	3.4	3.54	3.77	3.89
153	3.03	3	3.15	3.17	3.36	3.54	3.77	3.89
154	3.02	2.96	3.18	3.12	3.37	3.55	3.76	3.9
155	3.03	3.03	3.17	3.15	3.36	3.54	3.74	3.82
156	3.02	3.02	3.17	3.2	3.35	3.54	3.75	3.9
157	2.98	3.06	3.17	3.15	3.34	3.57	3.75	3.86
158	3.01	3.03	3.19	3.12	3.34	3.59	3.74	3.88
159	2.95	3.04	3.2	3.16	3.37	3.59	3.7	3.91
160	3	3.01	3.2	3.15	3.3	3.58	3.73	3.89
161	3	2.99	3.21	3.19	3.31	3.57	3.75	3.91
162	3.01	3.06	3.21	3.16	3.32	3.57	3.74	3.9
163	3.02	3.07	3.23	3.18	3.31	3.61	3.73	3.93
164	3	3.03	3.25	3.16	3.34	3.61	3.76	3.94
165	3	3.04	3.25	3.17	3.33	3.61	3.74	3.92
166	3	3.02	3.24	3.2	3.34	3.63	3.75	3.94

167	3.01	3.03	3.26	3.18	3.36	3.61	3.76	3.93
168	2.97	3	3.27	3.16	3.37	3.62	3.77	3.95
169	2.96	3.06	3.28	3.15	3.34	3.64	3.77	3.97
170	3	3	3.29	3.16	3.37	3.66	3.78	3.97
171	3	3.01	3.27	3.17	3.36	3.62	3.76	3.99
172	2.99	3.01	3.28	3.16	3.36	3.62	3.8	3.99
173	3.01	2.98	3.26	3.17	3.39	3.64	3.8	4.01
174	3.02	3.03	3.29	3.21	3.39	3.64	3.8	4.02
175	3.01	2.97	3.26	3.19	3.39	3.66	3.83	4.01
176	2.97	2.95	3.28	3.17	3.39	3.66	3.82	4.03
177	3.01	2.93	3.26	3.19	3.4	3.67	3.79	4.05
178	3.01	2.95	3.26	3.19	3.42	3.64	3.82	4.04
179	2.99	2.97	3.25	3.11	3.43	3.6	3.81	4.05
180	3.04	2.94	3.26	3.21	3.45	3.54	3.81	4.01
181	3.04	2.94	3.27	3.17	3.39	3.63	3.8	4.06
182	3.02	2.91	3.26	3.2	3.44	3.64	3.82	4.03
183	3.01	2.93	3.25	3.2	3.45	3.61	3.82	4.04
184	3.03	2.94	3.25	3.21	3.47	3.63	3.8	4.04
185	3.02	2.96	3.23	3.12	3.46	3.65	3.83	4.03
186	3.02	2.97	3.25	3.19	3.45	3.61	3.83	4.07
187	3.03	2.93	3.22	3.14	3.4	3.62	3.82	4.05
188	3.06	2.92	3.22	3.2	3.46	3.61	3.86	4.01
189	3.04	2.98	3.22	3.16	3.48	3.62	3.82	4.03
190	3.01	2.93	3.22	3.21	3.5	3.61	3.81	4.03
191	3.05	2.96	3.22	3.18	3.49	3.61	3.78	3.99
192	3.03	2.95	3.19	3.16	3.45	3.59	3.8	3.99
193	3	2.94	3.21	3.17	3.49	3.6	3.79	3.93
194	3.02	2.95	3.2	3.16	3.48	3.55	3.77	3.97
195	3.02	2.98	3.22	3.17	3.47	3.6	3.74	4.03
196	3.02	2.97	3.18	3.13	3.48	3.56	3.82	3.95
197	3	2.96	3.16	3.14	3.48	3.56	3.76	3.94
198	3.04	2.99	3.17	3.16	3.49	3.59	3.75	3.93
199	3.01	2.95	3.13	3.14	3.47	3.53	3.71	3.92
200	3.01	3	3.16	3.12	3.47	3.57	3.75	3.93

Lampiran 6.
Foto Alat

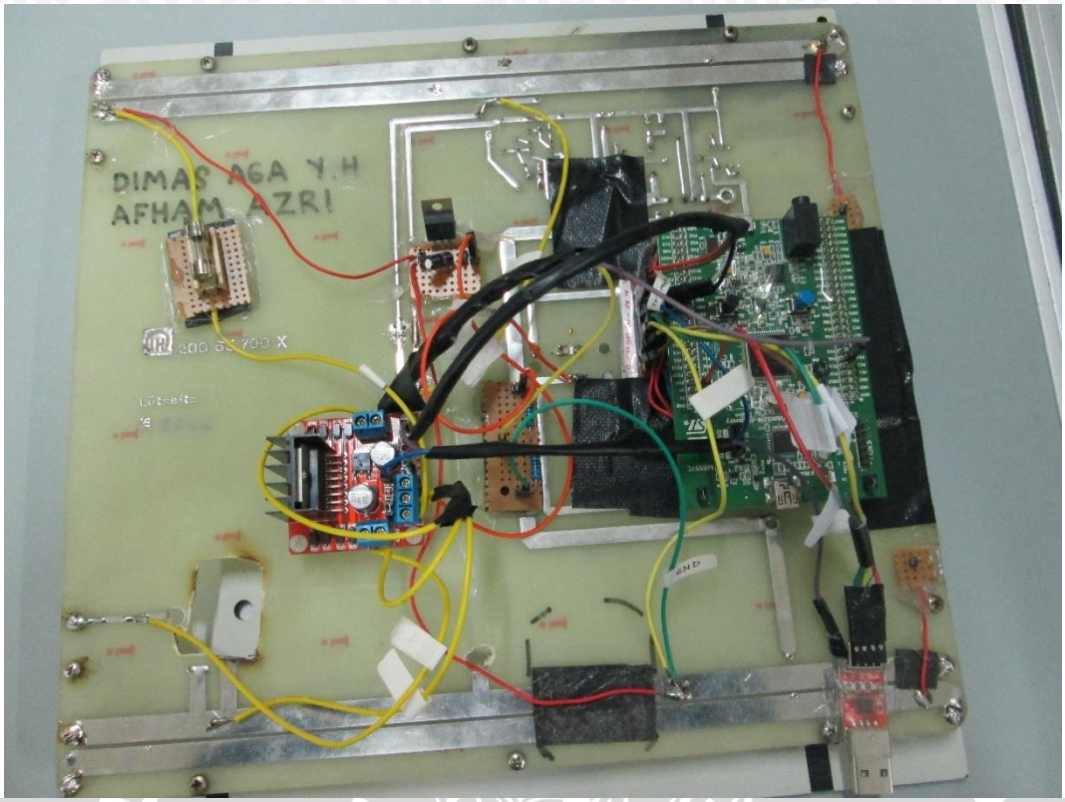


Foto Rangkaian STM32F4 *Discovery* dengan komponen lainnya

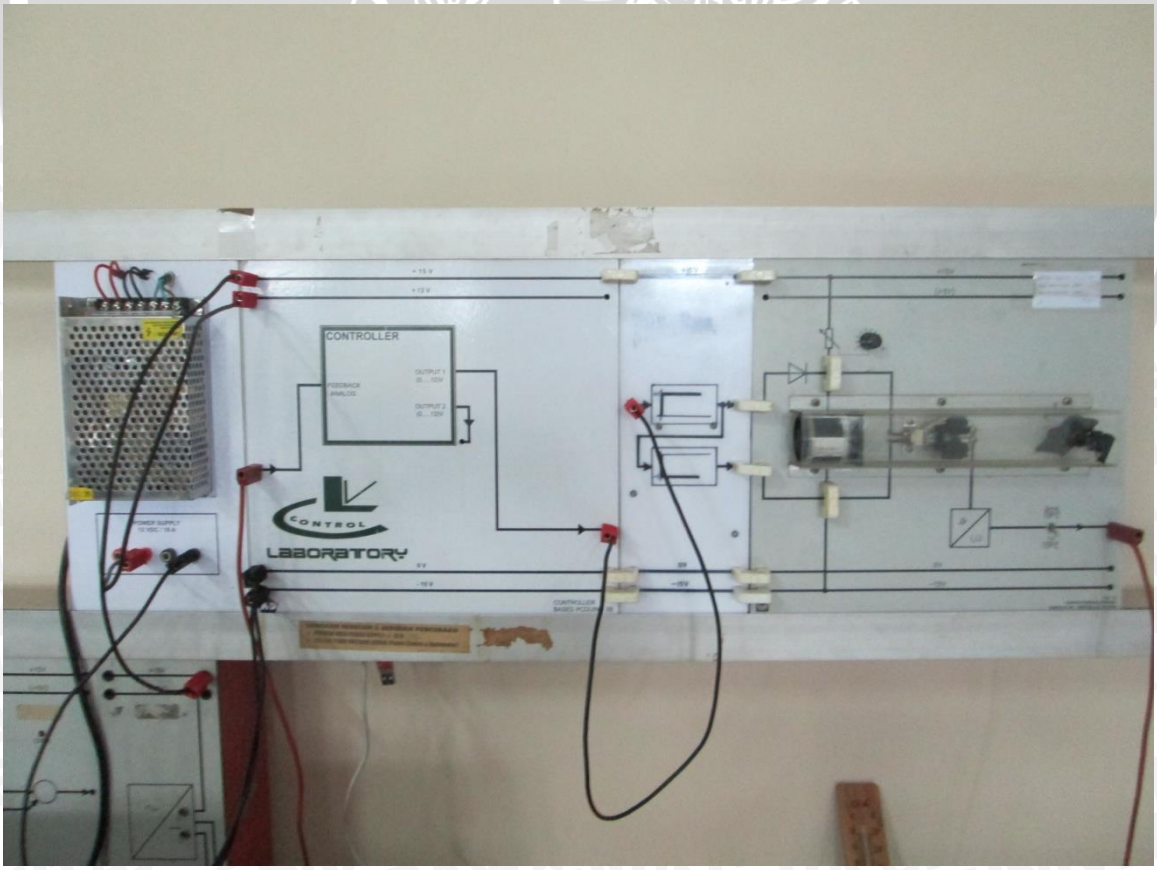


Foto Rangkaian Keseluruhan