Mathematical Manipulation of Pure Sine Wave Inverter Using Atmel 89S2051

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Introduction

Approach used for creating the pure sine wave described in this paper is done through manipulation of mathematical representation of the original sine wave. It is done by dividing half the sine wave into m (even number) segmentations, where area under a quarter of the sine wave from 0 to $\pi/2$ resembles series of the form [2n-1] where n=1,..., m/2, while areas of the next quarter from $\pi/2$ to π will resemble series of the form [2n-1] where n=m/2,.., 1.

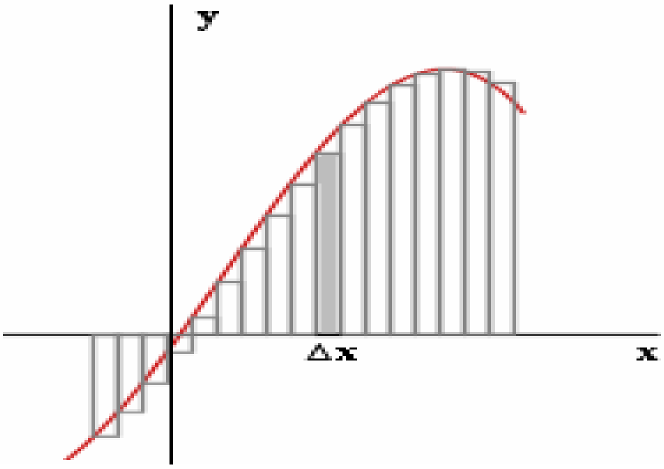


Figure 1. Dividing the sine wave into small segments

Block Diagram & Schematic

The inverter will converts 12 Volt dc from battery into 110 Volt ac, 50 Hz, sine wave. Figure 2 and 3 show the block dagram and schemnatic circuit of the inverter.

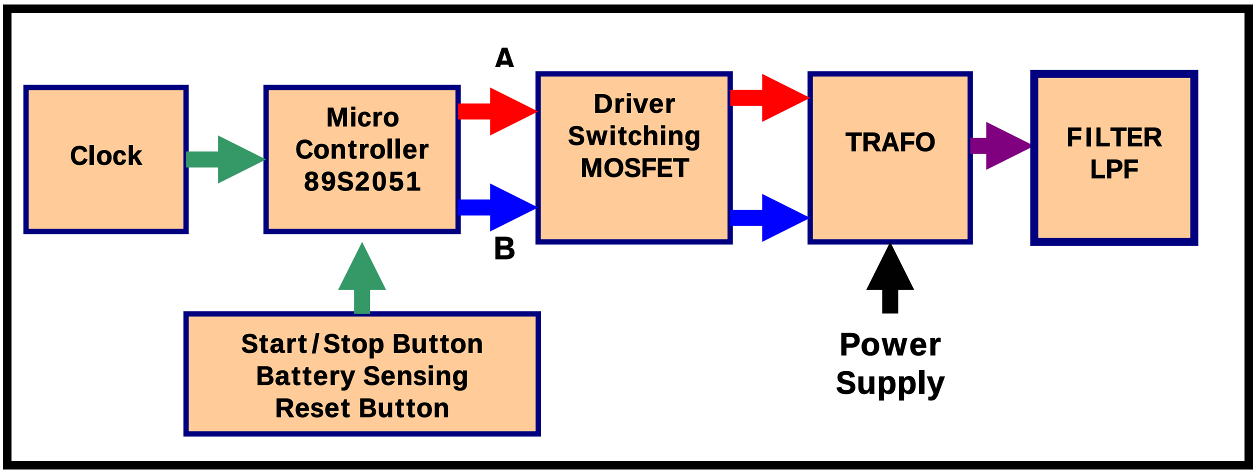


Figure 2. Block diagram of pure sine wave inverter

Pulse train as shown in figures 5 is produced interchangeably from port (A) and port (B) by microcontroller 89S2051 during the positive half and negative half of the sine wave. The pulse train is then inputted to the MOSFET power switching circuit, which is next directed to the primary side of the transformer. Output of the secondary side is shown in Figure 6, which then be filtered resulting in the sine wave as seen in figure 7, where amplitude attenuation can reach up to 50%. Measured inverter output THD reaches 5-8%, where the largest harmonics appeared to be the second and third harmonics as shown in figure 8.

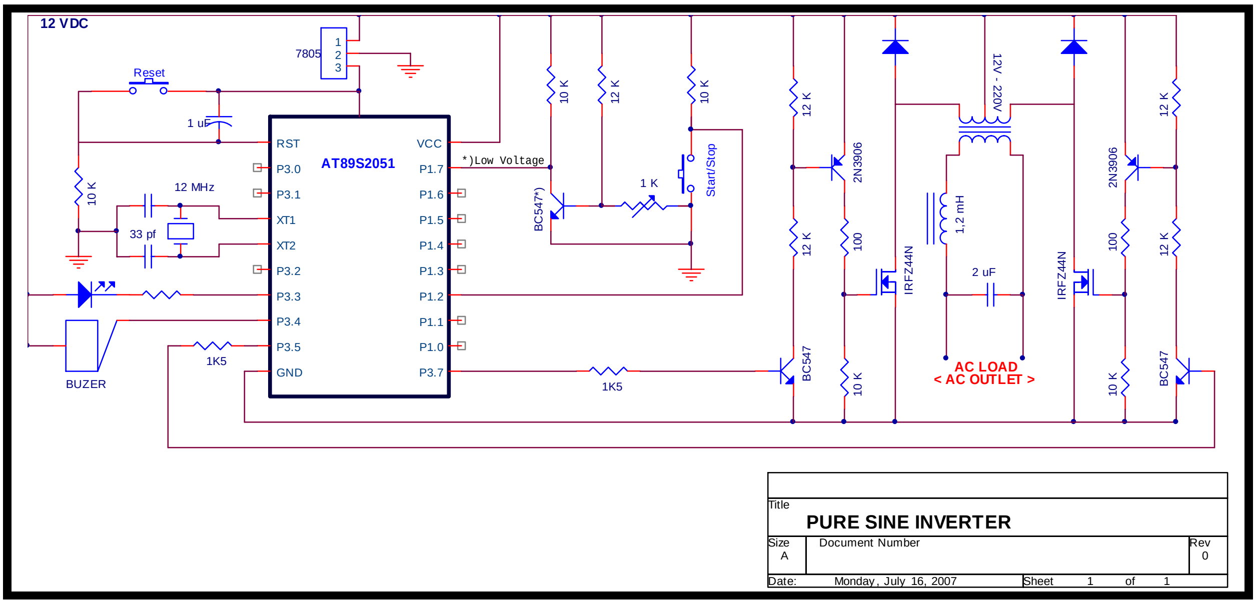


Figure 3. Schematic of Pure Sine Inverter

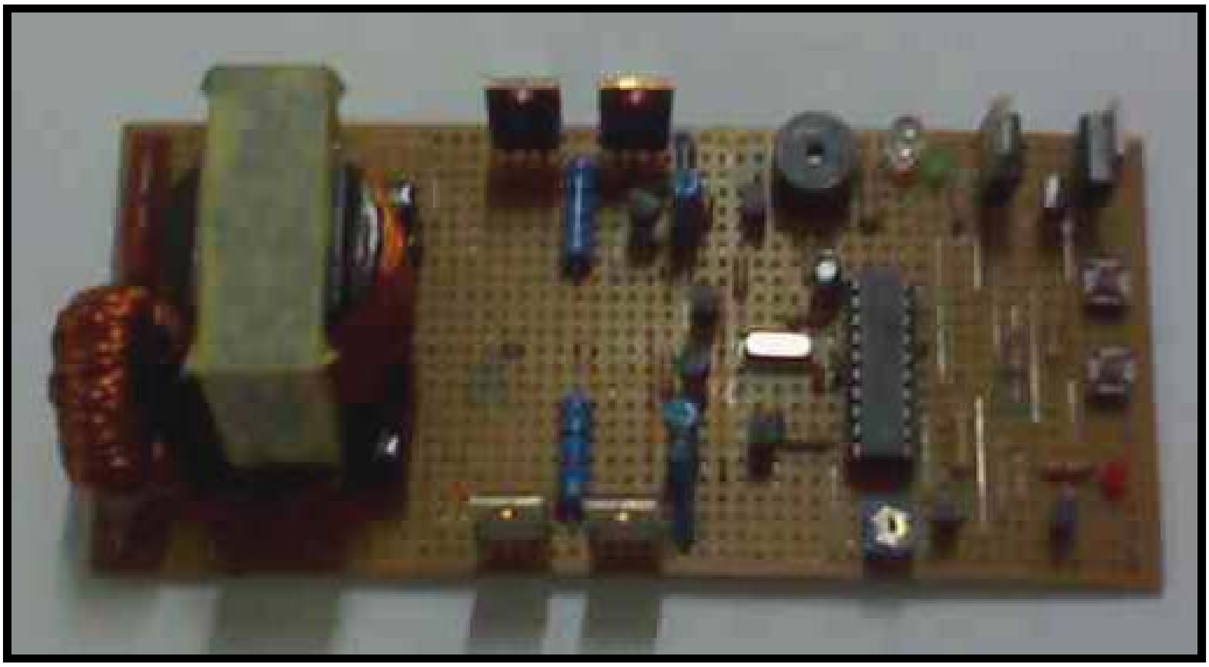


Figure 4. PCB of Pure Sine Inverter

Testing

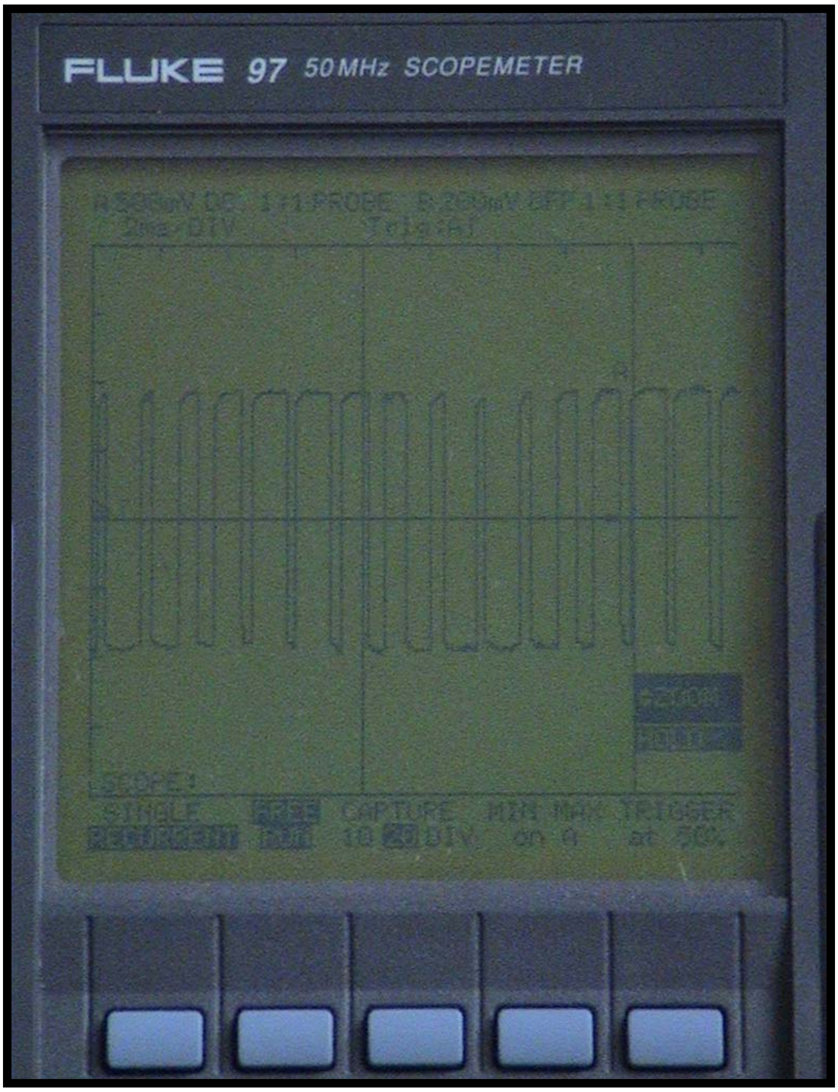


Figure 5. Pulse train (m=10) of Atmel 89s2051

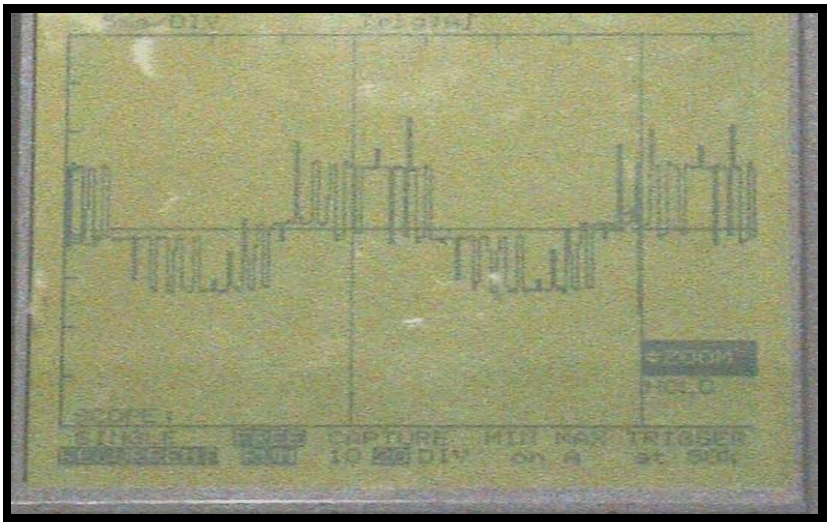


Figure 6. Secondary Side Transformer Output

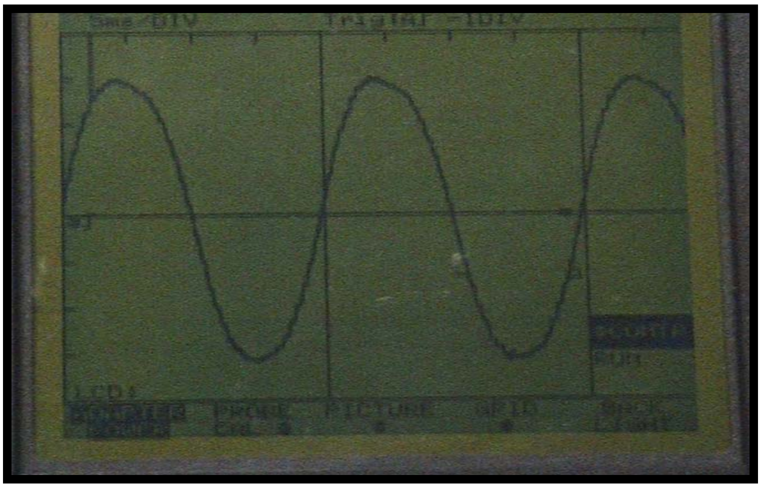
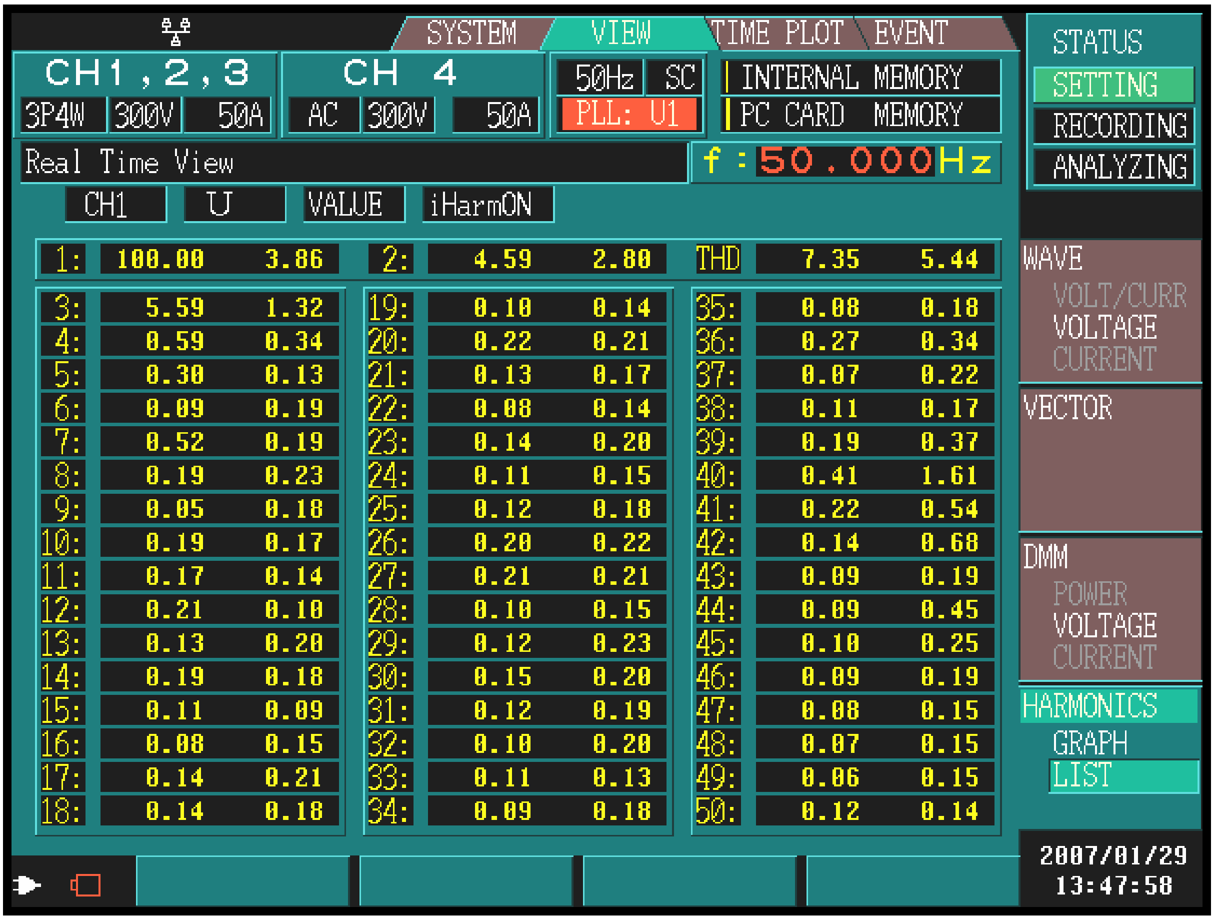


Figure 7. Filter Output



CH1,2,3 3P4W 300V 50A

CH 4 AC 300V 50A

50Hz SC PLL: U1

INTERNAL MEMORY

PC CARD MEMORY

Real Time View f : 50.000Hz

CH1 U VALUE iHarmON

1:	100.00	3.86	2:	4.59	2.80	THD	7.35	5.44
3:	5.59	1.32	19:	0.10	0.14	35:	0.08	0.18
4:	0.59	0.34	20:	0.22	0.21	36:	0.27	0.34
5:	0.30	0.13	21:	0.13	0.17	37:	0.07	0.22
6:	0.09	0.19	22:	0.08	0.14	38:	0.11	0.17
7:	0.52	0.19	23:	0.14	0.20	39:	0.19	0.37
8:	0.19	0.23	24:	0.11	0.15	40:	0.41	1.61
9:	0.05	0.18	25:	0.12	0.18	41:	0.22	0.54
10:	0.19	0.17	26:	0.20	0.22	42:	0.14	0.68
11:	0.17	0.14	27:	0.21	0.21	43:	0.09	0.19
12:	0.21	0.10	28:	0.10	0.15	44:	0.09	0.45
13:	0.13	0.20	29:	0.12	0.23	45:	0.10	0.25
14:	0.19	0.18	30:	0.15	0.20	46:	0.09	0.19
15:	0.11	0.09	31:	0.12	0.19	47:	0.08	0.15
16:	0.08	0.15	32:	0.10	0.20	48:	0.07	0.15
17:	0.14	0.21	33:	0.11	0.13	49:	0.06	0.15
18:	0.14	0.18	34:	0.09	0.18	50:	0.12	0.14

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Figure 8. Harmonic measurement result (Hioki)

Listing Software

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;===========================================
; PROGRAM INVERTER OLEH: DIDIK ROSTYONO 2006
;===========================================
;P1=INPUT              P3=OUTPUT
;P1.2=TOMBOL START     P1.3=BATERE CEK
;P3.0=DRIVER1          P3.1=DRIVER2
;P3.4=BUZZER           P3.5=LED

;INISIALISASI (BEEP PENDEK + BEEP PANJANG)
        ORG 00H
ON:     MOV P3,#20H;   DRIVER OFF, BUZZER OFF, LED OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SETB P3.4;     BEEP ON
        CLR P3.5;      LED BIRU ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        CLR P3.4;      BEEP OFF
        SETB P3.5;     LED BIRU OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SETB P3.4;     BEEP ON
        CLR P3.5;      LED BIRU ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        CLR P3.4;      BEEP OFF
        SETB P3.5;     LED BIRU OFF

;CEK KONDISI BATERE (LOW VOLTAGE = 2 X BEEP PENDEK)
CEK:    JNB P1.3,MULAI;        CEK KONDISI BATERE
        CLR P3.5;      LED BIRU ON
        SETB P3.4;     BEEP ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SETB P3.5;     LED BIRU OFF
        CLR P3.4;      BEEP OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        CLR P3.5;      LED BIRU ON
        SETB P3.4;     BEEP ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SETB P3.5;     LED BIRU OFF
        CLR P3.4;      BEEP OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SJMP CEK

;INVERTER MENUNGGU PENEKANAN TOMBOL ON
MULAI:  SETB P3.5;     LED BIRU OFF
        CLR P3.4;      BEEP OFF
MULAI1: JNB P1.2,START;        BACA TOMBOL START
        CLR P3.5;      LED BIRU ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        JNB P1.2,START;        BACA TOMBOL START
        SETB P3.5;     LED BIRU OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        AJMP CEK

;INVERTER ON
START:  SETB P3.5;     LED BIRU OFF
        CLR P3.4;      BEEP OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        ACALL DELAI;   TUNGGU 1/4 DETIK
        SETB P3.4;     BEEP ON
        CLR P3.5;      LED BIRU ON
        ACALL DELAI;   TUNGGU 1/4 DETIK
        CLR P3.4;      BEEP OFF
        ACALL DELAI;   TUNGGU 1/4 DETIK

;PWM GENERATOR
PULSE:  JNB P1.2,ON;   JIKA STOP DITEKAN KEMBALI KE AWAL
        JB P1.3,ON;    CEK KONDISI BATERE

PWM:    CLR P3.0;
        CLR P3.1;
        SETB P3.0;
        ACALL PULSE_TRAIN;
        CLR P3.0;
        CLR P3.1;
        ACALL PULSE_TRAIN;
        CLR P3.0;
        CLR P3.1;
        AJMP PULSE

;RUTIN DELAI1
DELAI:  MOV R1,#2
L1:     MOV R2,#250
L2:     MOV R3,#250
L3:     DJNZ R3,L3
        DJNZ R2,L2
        DJNZ R1,L1
        RET
```