LAMPIRAN

Lampiran 1. Program Mikrokontroler

```
EnLcd           bit     p2.6
RSLcd           bit     p2.7
DtLcd           equ     08h

DVolt           equ     12h
DArus           equ     13h
DCosp           equ     14h

                dseg    ;set alamat ram mulai 28h
                org      28H

Oprnd1:     DS      3
Oprnd2:     DS      3
HslOpr:     DS      3
SisaBagi:   DS      3

OpTmbh1:    DS      3
OpTmbh2:    DS      3
HslTmbh:    DS      3
OpKurang1:  DS      3
OpKurang2:  DS      3
HslKurang:  DS      3
DtBanding:  DS      3
TMPHslOp:   DS      3
TMPSisaBg:  DS      3
DtBCD:      DS      6

            cseg    ;set alamat rom mulai 00h
            org     00h
             JMP    Start
            org     30h
Start:      Call    InitLcd;tampilan lcd pertama kali

Loop:
;-------------------------------------------------------
WADC:                   clr     P3.0    ;set utk baca data sensor teg
                        setb    P3.1

                        mov     r5,#010
                        Call    ReadADC     ;baca ADC
                        mov     DVolt,a

                        mov     r0,#HslOpr
                        mov     @r0,a
```

```
                    Call    UbahKeBCD ;ubah data ke desimal

                    mov     r0,#052h
                    mov     r1,#02
                    mov     dtlcd,#0c2h
                    call    writekarmem   ;tampilkan data teg desimal
ke lcd

;-------------------------------------------------------
                    setb    P3.0    ;set utk baca data sensor arus
                    clr     P3.1
                    mov     r5,#010
                    Call    ReadADC       ;baca ADC

                    mov     r0,#HslOpr
                    mov     @r0,a
                    Call    UbahKeBCD

                    mov     r0,#052h
                    mov     r1,#02
                    mov     dtlcd,#0c9h
                    call    writekarmem

;-------------------------------------------------------
                    setb    P3.0    ;set inp 3 Sudut
                    setb    P3.1
                    mov     r5,#010
                    Call    ReadADC
                    Call    GetCosP
                    mov     DCosP,a

;-------------------------------------------------------
                    mov     r0,#Oprnd1
                    mov     @r0,DVolt

                    mov     a,darus
                    mov     r0,#Oprnd2
                    mov     @r0,DArus
                    Call    Perkalian       ;Teg*Arus

                    mov     a,dcosp
                    mov     r0,#Oprnd2
                    mov     @r0,Dcosp
                    Call    Perkalian       ;Power=Teg*Arus*CosP

                    Call    UbahKeBCD  ;ubah daya ke desimal
```

```
                    mov     r0,#050h        ;tampilkan Daya ke LCD
                    mov     r1,#03
                    mov     dtlcd,#0cdh
                    call    writekarmem

                    jmp     loop



;--------- Clear All Memmory ----------------------------------
ClrAll:             mov     r0,#02
ConClr:                     mov     @r0,#00
                    inc     r0
                    djnz    r1,ConClr
                    ret


;-------------------------------------------------------------
;--------------  Baca ADC
ReadADC:            mov     r6,#0ffh
RdLg:               mov     a,p1
                    djnz    r6,RdLg
                    djnz    r5,ReadADC
                    ret


;-------------------------------------------------------------------
GetCosP:            cjne    a,#0194,NCos1
                    mov     a,#099
                    ret
NCos1:                      cjne    a,#0195,NCos2
                    mov             a,#095
                    ret
NCos2:                      cjne    a,#0197,NCos3
                    mov             a,#089
                    ret
NCos3:                      cjne    a,#0188,NCos4
                    mov             a,#080
                    ret
NCos4:                      cjne    a,#0187,NCos5
                    mov             a,#070
                    ret
NCos5:                      cjne    a,#0186,NCos6
                    mov             a,#059
```

```
                    ret
NCos6:              cjne    a,#0188,NCos7
                    mov     a,#045
                    ret
NCos7:              cjne    a,#0189,NCos8
                    mov     a,#031
                    ret


NCos8:              mov     a,#01
                    ret


;-------------------------------------------------------------
;------- delay
Delay:              mov     r6,#0ffh
wait:               djnz    r6,$
                    djnz    r5,wait
                    ret

;-------------------------------------------------------------
;------- Ubah ke BCD
UbahKeBCD:
NextConv:           Mov     R0,#HslOpr
                    Mov     R1,#Oprnd1
                    Mov     R2,#03
                Call    Copy

                    Mov     R1,#Oprnd2
                    Mov     @R1,#010
                    Call    RtnPembagian

                    Mov     R0,#SisaBagi
                    Mov     A,@R0
                    Pop     01H
                    Mov     @R1,A
                    Dec     R2

                    Mov     R0,#HslOpr+2
            Mov     R1,#Oprnd2
            Mov         @R1,#09
            Call    Perbandingan
            JC          NextConv

                    Mov     R0,#HslOpr
                    Mov     A,@R0
```

```
                    Mov    @R1,A              ;simpan BCD(R3) Ke
mem Disp(R2)

                Ret


RtnPembagian:

                    MOV   R0,#OpTmbh2         ;set nilai
penambahan=1 u/hit byknya pengurangan
                    MOV   @R0,#01

LoopPembagian:
                    MOV   R0,#Oprnd1
                    MOV   R1,#Oprnd2
                    ACALL       Pengurangan

                    MOV   R0,#OpTmbh1         ;hasil pembagian di
Optmbh1
                    MOV   R1,#OpTmbh2
                    CALL  Penambahan
        ;OpTmbh1:=Optmbh1+Optmbh2

                    MOV   R0,#Oprnd1+2
                    MOV   R1,#Oprnd2+2
                    ACALL       Perbandingan
                    JC      LoopPembagian

                    RET


;
Perkalian:
;Inisial Var Pengurangan
                    MOV   R1,#OpKurang2
                    MOV   @R1,#01

LoopPerkalian:
                    MOV   R0,#Oprnd2
                    MOV   R1,#OpKurang2
                    ACALL       Pengurangan   ;Oprnd2:=Oprnd2-1

                    MOV   R0,#HslTmbh
                    MOV   R1,#Oprnd1
                    ACALL       Penambahan    ;Oprnd1:=Oprnd1+1
```

```
                    MOV   R0,#Oprnd2+2
                    MOV   R1,#DTBanding+2
                    CALL  Perbandingan
                    JB    F0,LoopPerkalian
                    RET
;
Penambahan:
                    MOV   R2,#3
LoopPenambahan:
                    MOV   A,@R0
                    ADD   A,@R1
                    MOV   @R0,A
                    INC   R0
                    INC   R1
                    DJNZ  R2,LoopPenambahan
                    RET
;
Perbandingan:
                    MOV   R2,#3
LoopPerbandingan:
                    MOV   A,@R0
                    SUBB  A,@R1
                    JZ    TKSAMA
                    SETB  C
                    DEC   R0
                    DEC   R1
                    DJNZ  R2,LoopPerbandingan
                    RET
TKSAMA:             CLR   F0
                    RET

;

;
Pengurangan:
                    MOV   R2,#3
LoopPengurangan:
                    MOV   A,@R0
                    SUBB  A,@R1
                    MOV   @R0,A
                    INC   R0
                    INC   R1
                    DJNZ  R2,LoopPengurangan
                    RET
;
HapusNilai:
```

```
                        MOV   @R0,#0
                        INC   R0
                        DJNZ  R2,HapusNilai
                        RET
;
Copy:

LCopy:                  MOV   A,@R0
                        MOV   @R1,A
                        INC   R0
                        INC   R1
                        DJNZ  R2,LCopy
                        RET

;-------------------------------------------------------------------------
IniTLCD:                Mov   DtLcd,#038H  ;Function Set
                        Call  WriteIR
                        Mov   DtLcd,#08h   ;disp Off
                        Call  WriteIR
                        Mov   DtLcd,#01    ;Disp CLear
                        Call  WriteIR
                        Mov   DtLcd,#06    ;Entry Set
                        Call  WriteIR

                        Mov   DtLcd,#038H  ;Function Set
                        Call  WriteIR
                        Mov   DtLcd,#0eh   ;disp On,blink
                        Call  WriteIR
                        Mov   DtLcd,#06h   ;entry mode set
                        Call  WriteIR

                        mov   dptr,#HDr1
                        mov   dtlcd,#080h
                        Call  WriteLn

                        mov   dptr,#Hdr2
                        mov   dtlcd,#0C0h
                        Call  WriteLn

                        Ret

;-------------------------------------------------------------------------------
;Tuliskan data kar pd mem
WriteKarMem:            Call  WriteIR
nextkarMem:             mov   a,@r0
                        clr   c
```

```
                    add     a,#030h
                    mov     dtlcd,a
                    Call    WriteDt
                    inc     r0
                    djnz    r1,nextkarmem
                    ret


;-------------------------------------------------------------------------------
;Tuliskan data ke baris 1
WriteLn:            Call    WriteIR
                    mov     r0,#016
                    mov     r1,#0
ndtkar:             mov     a,r1
                    Movc    a,@a+dptr
                    mov     dtlcd,a
                    Call    WriteDt
                    inc     r1
                    djnz    r0,ndtkar
                    ret

;-------------------------------------------------------------------------------
;Kirimkan Instruksi Ke LCD
WriteIR:            clr     RsLcd       ;RS   = 0 Instruction Reg
                    Mov     P0,DtLcd    ;Code Instruksi
                    Call    ClockE      ;CLock Enable Signal L-H-L
                    Ret

;-------------------------------------------------------------------------------
;Kirimkan Data Ke LCD
WriteDt:            setb    RsLcd       ;RS   = 1 Data
                    Mov     P0,DtLcd    ;Data
                    Call    ClockE      ;CLock Enable Signal L-H-L
                    Ret

;-------------------------------------------------------------------------------

;Memberikan sinyal clock pd pin E-LCD
ClockE:             clr     EnLcd
                    setb    EnLcd
                    clr     EnLcd
                    ret
```

```
Hdr1:       Db '   Watt Meter   '
Hdr2:       Db 'V=000A=0.00P=000'
Hapus:      Db '                '


end
```

National Semiconductor

February 1995

LM2907/LM2917 Frequency to Voltage Converter

General Description

The LM2907, LM2917 series are monolithic frequency to voltage converters with a high gain op amp/comparator designed to operate a relay, lamp, or other load when the input frequency reaches or exceeds a selected rate. The tachometer uses a charge pump technique and offers frequency doubling for low ripple, full input protection in two versions (LM2907-8, LM2917-8) and its output swings to ground for a zero frequency input.

Advantages

- Output swings to ground for zero frequency input
- Easy to use: $V_{OUT} = f_{IN} \times V_{CC} \times R1 \times C1$
- Only one RC network provides frequency doubling
- Zener regulator on chip allows accurate and stable frequency to voltage or current conversion (LM2917)

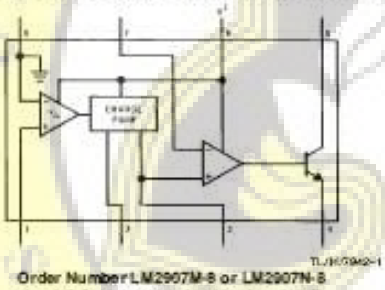
Features

- Ground referenced tachometer input interfaces directly with variable reluctance magnetic pickups
- Op amp/comparator has floating transistor output
- 50 mA sink or source to operate relays, solenoids, motors, or LEDs
- Frequency doubling for low ripple
- Tachometer has built-in hysteresis with either differential input or ground referenced input
- Built-in zener on LM2917
- ±0.3% linearity typical
- Ground referenced tachometer is fully protected from damage due to swings above V_{CC} and below ground

Applications

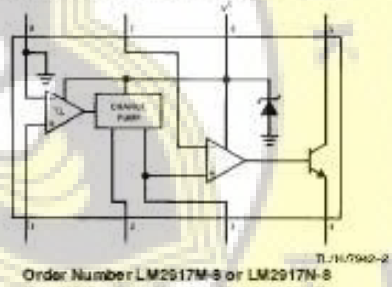
- Over/under speed sensing
- Frequency to voltage conversion (tachometer)
- Speedometers
- Breaker point dwell meters
- Hand-held tachometer
- Speed governors
- Cruise control
- Automotive door lock control
- Clutch control
- Horn control
- Touch or sound switches

Block and Connection Diagrams Dual-In-Line and Small Outline Packages, Top Views



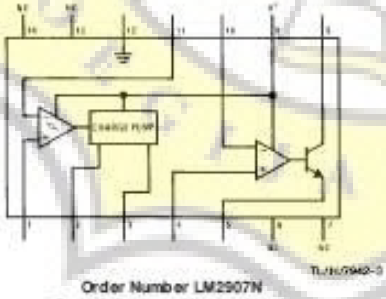
TL/H/7942–1

Order Number LM2907M-8 or LM2907N-8
See NS Package Number M08A or N08E



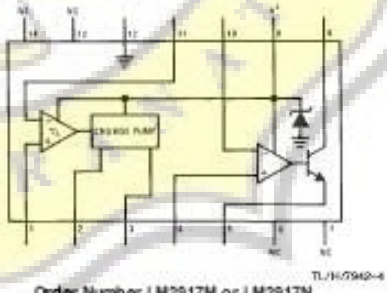
TL/H/7942–2

Order Number LM2917M-8 or LM2917N-8
See NS Package Number M08A or N08E



TL/H/7942–3

Order Number LM2907N
See NS Package Number N14A



TL/H/7942–4

Order Number LM2917M or LM2917N
See NS Package Number M14A or N14A

RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	28V
Supply Current (Zener Options)	25 mA
Collector Voltage	28V
Differential Input Voltage	
Tachometer	28V
Op Amp/Comparator	28V
Input Voltage Range	
Tachometer LM2907-8, LM2917-8	± 28V
LM2907, LM2917	0.0V to + 28V
Op Amp/Comparator	0.0V to + 28V
Power Dissipation	
LM2907-8, LM2917-8	1200 mW
LM2907-14, LM2917-14	1500 mW
(See Note 1)	
Operating Temperature Range	−40°C to + 85°C
Storage Temperature Range	−65°C to + 150°C
Soldering Information	
Dual-In-Line Package	
Soldering (10 seconds)	260°C
Small Outline Package	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

Electrical Characteristics V_{CC} = 12 V_{DC}, T_A = 25°C, see test circuit

Symbol	Parameter	Conditions	Min	Typ	Max	Units
TACHOMETER						
	Input Thresholds	V_{IN} = 250 mVp-p @ 1 kHz (Note 2)	± 10	± 25	± 40	mV
	Hysteresis	V_{IN} = 250 mVp-p @ 1 kHz (Note 2)		30		mV
	Offset Voltage	V_{IN} = 250 mVp-p @ 1 kHz (Note 2)				
	LM2907/LM2917			3.5	10	mV
	LM2907-8/LM2917-8			5	15	mV
	Input Bias Current	V_{IN} = ± 50 mV$_{DC}$		0.1	1	µA
V_{OH}	Pin 2	V_{IN} = +125 mV$_{DC}$ (Note 3)		6.3		V
V_{OL}	Pin 2	V_{IN} = −125 mV$_{DC}$ (Note 3)		2.3		V
I_{O1} I_{O2}	Output Current	V2 = V3 = 6.0V (Note 4)	140	180	240	µA
I_O	Leakage Current	I2 = 0, V3 = 0			0.1	µA
K	Gain Constant	(Note 3)	0.9	1.0	1.1	
	Linearity	f_{IN} = 1 kHz, 5 kHz, 10 kHz (Note 5)	−1.0	0.3	+1.0	%
OP/AMP COMPARATOR						
V_{OS}		V_{IN} = 6.0V		3	10	mV
I_{BIAS}		V_{IN} = 6.0V		50	500	nA
	Input Common-Mode Voltage		0		V_{CC} − 1.5V	V
	Voltage Gain			200		V/mV
	Output Sink Current	V_C = 1.0	40	50		mA
	Output Source Current	V_E = V_{CC} − 2.0		10		mA
	Saturation Voltage	I_{SINK} = 5 mA		0.1	0.5	V
		I_{SINK} = 20 mA			1.0	V
		I_{SINK} = 50 mA		1.0	1.5	V

Electrical Characteristics V_{CC} = 12 V_{DC}, T_A = 25°C, see test circuit (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
ZENER REGULATOR						
	Regulator Voltage	R_{SUPPLY} = 470Ω		7.56		V
	Series Resistance			10.5	15	Ω
	Temperature Stability			+1		mV/°C
	TOTAL SUPPLY CURRENT			3.8	6	mA

Note 1: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 161°C/W junction to ambient for LM2907-8 and LM2914-8, and 106°C/W junction to ambient for LM2907-14 and LM2917-14.

Note 2: Hysteresis is the sum of $|V_{TH}| + |-V_{TH}|$, offset voltage is the difference between the two.

Note 3: V_{OH} is set for 5% < V_{CC} − 1 V_{BE}, V_{OL} is set for 5% < V_{CC} − 1 V_{BE} and $V_{OH} - V_{OL} = V_{CC}/2$. The difference, $V_{OH} - V_{OL}$, and the mirror gain, I_2/I_1, are the two factors that cause the tachometer gain error not to be equal to unity (1.0).

Note 4: Be sure when choosing the time constant R1 × C1 that R1 is not so large that the maximum available output voltage at pin 3 can be reached with I_3 × R1. The maximum value for R1 is limited by the output resistance of pin 3 which is greater than 10 MΩ typically.

Note 5: Nonlinearity is defined as the deviation of V_{OUT} @ pin 3) for f_{IN} = 5 kHz from a straight line defined by the V_{OUT} @ 1 kHz and V_{OUT} @ 10 kHz. C1 = 1000 pF, R1 = 68k and C2 = 0.22 mF.

General Description (Continued)

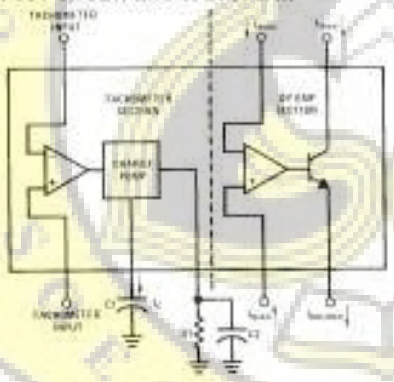
The op amp/comparator is fully compatible with the tachometer and has a floating transistor as the output. This feature allows either a ground or supply referenced load of up to 50 mA. The collector may be taken above V_{CC} up to a maximum V_{CE} of 28V.

The two basic configurations offered include an 8-pin device with a *ground referenced* tachometer input and an internal connection between the tachometer output and the op amp non-inverting input. This version is well suited for single speed or frequency switching or fully buffered frequency to voltage conversion applications.

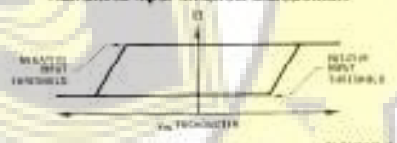
The more versatile configurations provide differential tachometer input and uncommitted op amp inputs. With this version the tachometer input may be floated and the op amp becomes suitable for active filter conditioning of the tachometer output.

Both of these configurations are available with an active shunt regulator connected across the power leads. The regulator clamps the supply such that stable frequency to voltage and frequency to current operations are possible with any supply voltage and a suitable resistor.

Test Circuit and Waveform



Tachometer Input Threshold Measurement



LM324, LM324A, LM224, LM2902, LM2902V, NCV2902

Single Supply Quad Operational Amplifiers

The LM324 series are low−cost, quad operational amplifiers with true differential inputs. They have several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V with quiescent currents about one−fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

- Short Circuited Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V (LM224, LM324, LM2902)
- Low Input Bias Currents: 100 nA Maximum (LM324A)
- Four Amplifiers Per Package
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Industry Standard Pinouts
- ESD Clamps on the Inputs Increase Ruggedness without Affecting Device Operation

MAXIMUM RATINGS (T_A = +25°C unless otherwise noted)

Rating	Symbol	LM324 LM324A LM224A	LM2902 LM2902V	Unit
Power Supply Voltages Single Supply Split Supplies	V_{CC} V_{CC}, V_{EE}	32 ±16	26 ±13	Vdc
Input Differential Voltage Range (Note 1)	V_{IDR}	±32	±26	Vdc
Input Common Mode Voltage Range	V_{ICR}	−0.3 to 32	−0.3 to 26	Vdc
Output Short Circuit Duration	t_{SC}	Continuous		
Junction Temperature	T_J	150		°C
Storage Temperature Range	T_{stg}	−65 to +150		°C
Operating Ambient Temperature Range LM224 LM324, 324A LM2902 LM2902V, NCV2902	T_A	−25 to +85 0 to +70	−40 to +125 −40 to +125	°C

1. Split Power Supplies.

ON Semiconductor

http://onsemi.com

PDIP−14
N SUFFIX
CASE 646

SO−14
D SUFFIX
CASE 751A

TSSOP−14
DTB SUFFIX
CASE 948G

PIN CONNECTIONS

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = Gnd, T_A = 25°C, unless otherwise noted.)

Characteristics	Symbol	LM324			LM324A			LM224			LM2902			LM2902V and NCV2902			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage V_{CC} = 5.0 Vdc to 30 V (26 V for LM2902, V); V_{CM} = 0 V to V_{CC} − 1.7 V, V_O = 1.4 V, R_S = 0 Ω T_A = 25°C T_A = T_{high} (Note 2) T_A = T_{low} (Note 2)	V_{IO}	– – –	2.0 – –	4.0 7.0 7.0	– – –	1.0 – –	3.0 5.0 5.0	– – –	2.0 – –	5.0 9.0 9.0	– – –	2.0 – –	7.0 10 10	– – –	2.0 – –	7.0 10 10	mV
Average Temperature Coefficient of Input Offset Voltage T_A = T_{high} to T_{low} (Note 3 and 4)	$\Delta V_{IO}/\Delta T$	–	7.0	–	–	7.0	30	–	7.0	–	–	7.0	–	–	7.0	–	μV/°C
Input Offset Current T_A = T_{high} to T_{low} (Note 2)	I_{IO}	– –	3.0 –	30 100	– –	5.0 –	50 75	– –	5.0 –	50 150	– –	5.0 –	50 200	– –	5.0 –	50 200	nA
Average Temperature Coefficient of Input Offset Current T_A = T_{high} to T_{low} (Note 3 and 4)	$\Delta I_{IO}/\Delta T$	–	10	–	–	10	300	–	10	–	–	10	–	–	10	–	pA/°C
Input Bias Current T_A = T_{high} to T_{low} (Note 2)	I_{IB}	– –	−45 –	−150 −300	– –	−45 –	−100 −200	– –	−45 –	−250 −500	– –	−45 –	−250 −500	– –	−45 –	−250 −500	nA
Input Common Mode Voltage Range (Note 5) V_{CC} = 30 V (26 V for LM2902, V) T_A = +25°C T_A = T_{high} to T_{low} (Note 2)	V_{ICR}	0 0	– –	28.3 28	0 0	– –	28.3 28	0 0	– –	28.3 28	0 0	– –	24.3 24	0 0	– –	24.3 24	V
Differential Input Voltage Range	V_{IDR}	–	–	V_{CC}	–	–	V_{CC}	–	–	V_{CC}	–	–	V_{CC}	–	–	V_{CC}	V
Large Signal Open Loop Voltage Gain R_L = 2.0 kΩ, V_{CC} = 15 V, for Large V_O Swing T_A = T_{high} to T_{low} (Note 2)	A_{VOL}	50 25	100 –	– –	75 50	100 –	– –	25 15	100 –	– –	25 15	100 –	– –	25 15	100 –	– –	V/mV
Channel Separation f(dm) = 0.1 Hz to 20 kHz, Input Referenced	CS	–	−120	–	–	−120	–	–	−120	–	–	−120	–	–	−120	–	dB
Common Mode Rejection R_S ≤ 10 kΩ	CMR	70	85	–	65	70	–	65	70	–	50	70	–	50	70	–	dB
Power Supply Rejection	PSR	65	100	–	65	100	–	65	100	–	50	100	–	50	100	–	dB

2. LM224: T_{low} = −25°C, T_{high} = +85°C
LM324/LM324A: T_{low} = 0°C, T_{high} = +70°C
LM2902: T_{low} = −40°C, T_{high} = +105°C
LM2902V and NCV2902: T_{low} = −40°C, T_{high} = +125°C
NCV2902 is qualified for automotive use.
3. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V_{CC} − 1.7 V.
4. Guaranteed by design.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = Gnd, T_A = 25°C, unless otherwise noted)

Characteristic	Symbol	LM324			LM324A			LM224			LM2902			LM2902V and NCV2902			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Output Voltage−High Limit (I_O = I_{source} at V_{out}) (Note 6) V_{CC} = 5.0 V, R_L = 2.0 kΩ, T_A = 25°C	V_{OH}	3.3	3.5	–	3.3	3.5	–	3.3	3.5	–	3.3	3.5	–	3.3	3.5	–	V
V_{CC} = 30 V (26 V for LM2902, V) R_L = 2.0 kΩ		26	–	–	26	–	–	26	–	–	22	–	–	22	–	–	
V_{CC} = 30 V (26 V for LM2902, V) R_L = 10 kΩ		27	28	–	27	28	–	27	28	–	23	24	–	23	24	–	
Output Voltage−Low Limit V_{CC} = 5.0 V, R_L = 10 kΩ, T_A = T_{high} to T_{low} (Note 6)	V_{OL}	–	5.0	20	–	5.0	20	–	5.0	20	–	5.0	100	–	5.0	100	mV
Output Sink Current (V_{in-} = 1.0 V, V_{in+} = 0 V) T_A = 25°C	I_{O-}	20	40	–	20	40	–	20	40	–	20	40	–	20	40	–	mA
T_A = T_{high} to T_{low} (Note 6)		10	20	–	10	20	–	10	20	–	10	20	–	10	20	–	
Output Source Current (V_{in+} = 1.0 V, V_{in-} = 0 V) T_A = 25°C	I_{O+}	20	30	–	20	30	–	20	30	–	20	30	–	20	30	–	mA
T_A = T_{high} to T_{low} (Note 6)		5.0	5.0	–	5.0	5.0	–	5.0	5.0	–	5.0	5.0	–	5.0	5.0	–	
(V_{in+} = 1.0 V, V_{in-} = 200 mV) T_A = 25°C		10	20	–	10	20	–	10	20	–	–	–	–	–	–	–	μA
Output Short Circuit to Ground (Note 6)	I_{SC}	–	40	60	–	40	60	–	40	60	–	40	60	–	40	60	mA
Power Supply Current (T_A = T_{high} to T_{low}) (Note 6) V_{CC} = 30 V (26 V for LM2902, V) V_O = 0 V, R_L = ∞	I_{CC}	–	–	3.0	–	1.4	3.0	–	–	3.0	–	–	3.0	–	–	3.0	mA
V_{CC} = 5.0 V, V_O = 0 V, R_L = ∞		–	–	1.2	–	0.7	1.2	–	–	1.2	–	–	1.2	–	–	1.2	

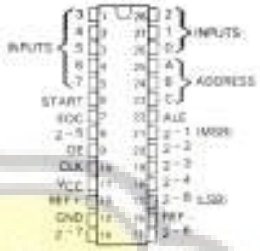
5. LM324: T_{high} = +85°C, T_{low} = −40°C
LM324A/224A: T_{high} = +85°C, T_{low} = −10°C
LM2902: T_{high} = +105°C, T_{low} = −40°C
LM2902V, NCV2902: T_{high} = +105°C, T_{low} = −40°C
NCV2902 is qualified for automotive use
6. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V_{CC} −1.5 V.

ADC0808, ADC0809
CMOS ANALOG-TO-DIGITAL CONVERTERS WITH 8-CHANNEL MULTIPLEXERS

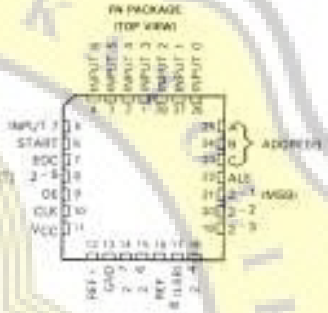
D2643, JUNE 1981 – REVISED MAY 1994

- Total Unadjusted Error . . . ±0.75 LSB Max for ADC0808 and ±1.25 LSB Max for ADC0809
- Resolution of 8 Bits
- 100 µs Conversion Time
- Ratiometric Conversion
- Monotonicity Over the Entire A/D Conversion Range
- No Missing Codes
- Easy Interface with Microprocessors
- Latched 3-State Outputs
- Latched Address Inputs
- Single 5-V Supply
- Low Power Consumption
- Designed to be Interchangeable with National Semiconductor ADC0808, ADC0809

N
DUAL-IN-LINE PACKAGE
(TOP VIEW)



NA PACKAGE
(TOP VIEW)



description

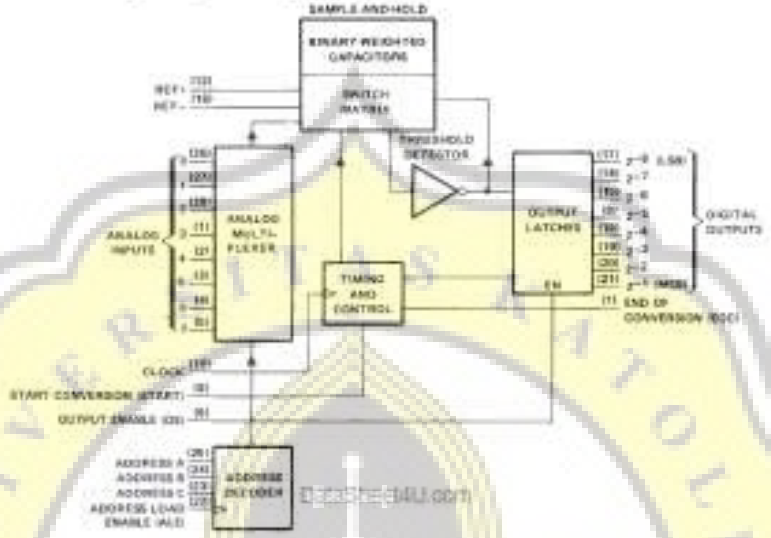
The ADC0808 and ADC0809 are monolithic CMOS devices with an 8-channel multiplexer, an 8-bit analog-to-digital (A/D) converter, and microprocessor-compatible control logic. The 8-channel multiplexer can be controlled by a microprocessor through a 3-bit address decoder with address load to select any one of eight single-ended analog switches connected directly to the comparator. The 8-bit A/D converter uses the successive-approximation conversion technique featuring a high-impedance threshold detector, a switched-capacitor array, a sample-and-hold, and a successive-approximation register (SAR). Detailed information on interfacing to most popular microprocessors is readily available from the factory.

The comparison and converting methods used eliminate the possibility of missing codes, nonmonotonicity, and the need for zero or full-scale adjustment. Also featured are latched 3-state outputs from the SAR and latched inputs to the multiplexer address decoder. The single 5-V supply and low power requirements make the ADC0808 and ADC0809 especially useful for a wide variety of applications. Ratiometric conversion is made possible by access to the reference voltage input terminals.

The ADC0809 and ADC0808 are characterized for operation from −40°C to 85°C.

TEXAS INSTRUMENTS

functional block diagram (positive logic)



MULTIPLEXER FUNCTION TABLE

INPUTS				SELECTED
ADDRESS			ADDRESS	ANALOG
C	B	A	STROBE	CHANNEL
L	L	L	↑	0
L	L	H	↑	1
L	H	L	↑	2
L	H	H	↑	3
H	L	L	↑	4
H	L	H	↑	5
H	H	L	↑	6
H	H	H	↑	7

H = High Level, L = Low Level
↑ = Low-to-High Transition

Features

- Compatible with MCS®-51 Products
- 4K Bytes of In-System Programmable (ISP) Flash Memory
  - Endurance: 1000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Watchdog Timer
- Dual Data Pointer
- Power-off Flag
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)

Description

The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In-System Programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with In-System Programmable Flash on a monolithic chip, the Atmel AT89S51 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

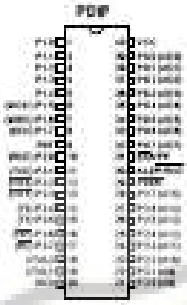
The AT89S51 provides the following standard features: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, two 16-bit timer/counters, a five-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next external interrupt or hardware reset.

8-bit Microcontroller with 4K Bytes In-System Programmable Flash

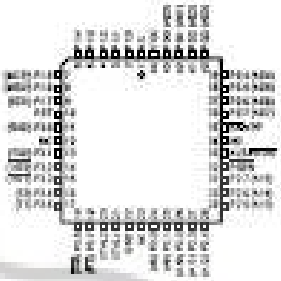
AT89S51

Pin Configurations

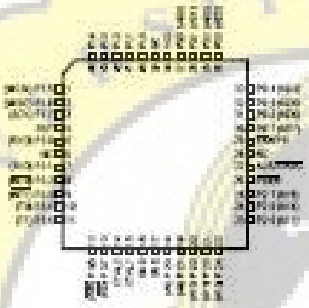
PDIP



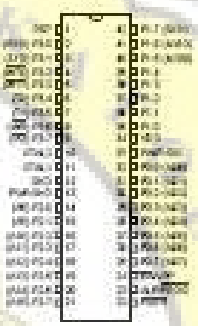
PLCC



TQFP



PDIP



Block Diagram