Motor Control – Part 2

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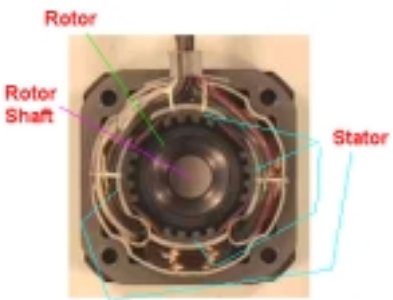
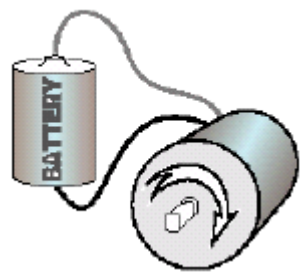
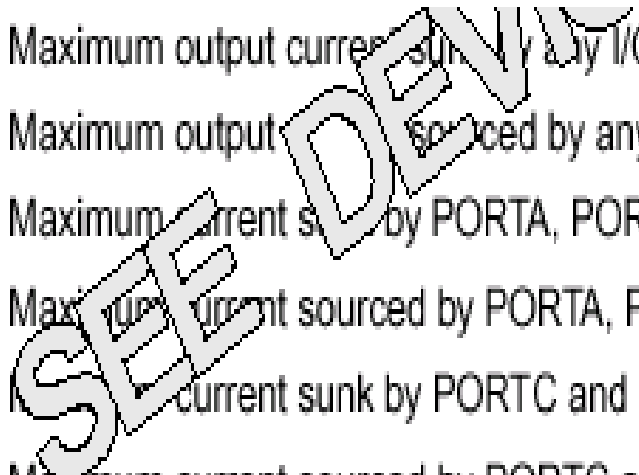
Howard University





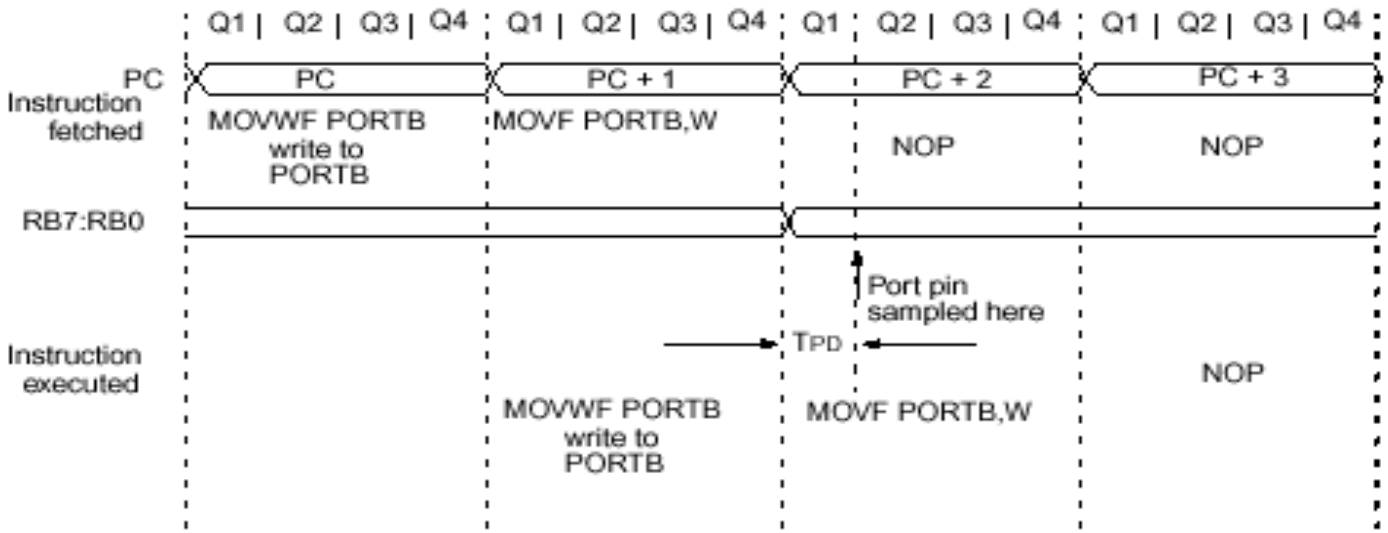
EECE691: Embedded Computing

PIC Driving Capability

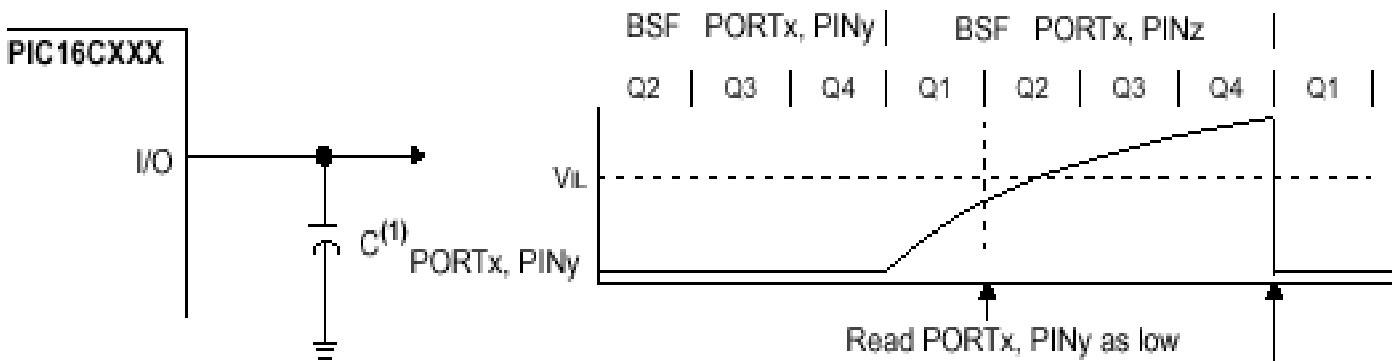


Maximum output current sunk by any I/O pin	25 mA
Maximum output sourced by any I/O pin	25 mA
Maximum current sunk by PORTA, PORTB, and PORTE (combined)	200 mA
Maximum current sourced by PORTA, PORTB, and PORTE (combined)	200 mA
Maximum current sunk by PORTC and PORTD (combined)	200 mA
Maximum current sourced by PORTC and PORTD (combined)	200 mA
Maximum current sourced by PORTC and PORTD (combined)	200 mA
Maximum current sourced by PORTF and PORTG (combined)	100 mA
Maximum current sourced by PORTF and PORTG (combined)	100 mA

PIC Successive I/O Operation (Write-Read)



This example shows a write to PORTB followed by a read from PORTB.



Note: This is not a capacitor to ground, but the effective capacitive loading on the trace.

Relays

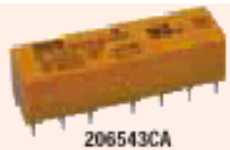
CLARE

FUJITSU

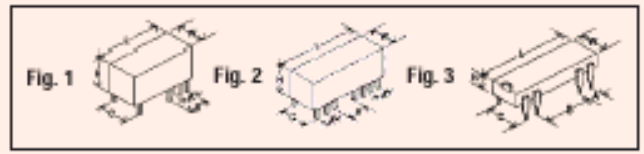
Aromat

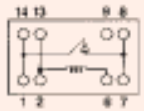

106462CA

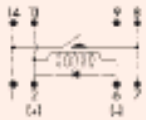

99901CA

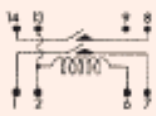

206543CA


215909CA

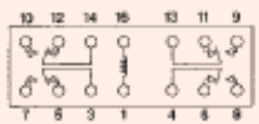



Schematic 1


Schematic 2


Schematic 3


Schematic 4


Schematic 5


Schematic 6


Schematic 7


Schematic 8

Part No.	Mfr. Cross Reference No.	Manufacturer	Contact Schem.	Contact Form	Coil Voltage	Coil Ohms	Contact Voltage	Contact Current	Pins	Jameco Socket	Fig.	Size L x W x H (in.)	Leads A x B x C (in.)	Pricing 1	10	50	100
106462CA	201A05	Excel Cell Elect.	1	SPST-NO	5VDC	500	100VDC	0.5A	8	37161	3	.78 x .25 x .20	.10 x .40 x .30	$2.15	$1.81	$1.52	$1.25
138430CA	2D1A05	Excel Cell Elect.	2	SPST-NO	5VDC	500	100VDC	0.5A	8	37161	3	.77 x .30 x .22	.10 x .40 x .30	2.29	1.95	1.65	1.34
215896CA	OJE-SS-109LMF	OEG	7	SBT-NO	9VDC	400	250VAC/30VDC	3A/3A	4	—	1	.71 x .39 x .57	.50 x .60 x .30	2.29	1.95	1.69	1.39
106471CA	201A12	Excel Cell Elect.	1	SPST-NO	12VDC	1000	100VDC	0.5A	8	37161	3	.78 x .25 x .20	.10 x .40 x .30	2.29	1.95	1.65	1.39
138448CA	2D1A1200	Excel Cell Elect.	2	SPST-NO	12VDC	1000	100VDC	0.5A	8	37161	3	.77 x .30 x .22	.10 x .40 x .30	2.25	1.95	1.75	1.49
192760CA	5MBU-5	Fujitsu	6	DPST-NO	5VDC	35	240VAC/24VDC	5A	8	—	1	1.13 x .50 x .98	.17 x .76 x .28	1.95	1.75	1.49	1.25
138456CA	202A05	Excel Cell Elect.	3	DPST-NO	5VDC	140	100VDC	0.5A	8	37161	3	.77 x .30 x .28	.10 x .40 x .30	3.49	3.15	2.69	2.19
173913CA	AZ831-2C-5DSE	American Zettler	4	DPDT	5VDC	125	125VAC/100VDC	.5A/1.25A	8	37401	1	.79 x .38 x .44	.18 x .28 x .29	2.35	2.15	1.69	1.25
139977CA	RSB5S	Shin Mei	4	DPDT	5VDC	125	120VAC/30VDC	1A/2A	8	37372	1	.79 x .39 x .37	.20 x .40 x .30	2.49	2.25	1.95	1.75
99338CA	LM12C00	Clare	4	DPDT	6VDC	71	125VAC/100VDC	2A	8	37372	1	.79 x .40 x .43	.20 x .40 x .30	2.49	2.19	1.59	1.29
99311CA	DS2Y-S-DC12V*	Aromat (NAIS)	4	DPDT	12VDC	720	110VAC/30VDC	.3A/1A	8	37372	1	.79 x .40 x .43	.20 x .40 x .30	2.49	2.31	2.05	1.75
99901CA	LX200D00	Clare	4	DPDT	12VDC	720	125VAC/100VDC	2A	8	37372	1	.79 x .40 x .30	.20 x .40 x .30	6.95	6.25	5.63	4.49
99320CA	LM12E00*	NEC	4	DPDT	24VDC	1110	125VAC/100VDC	2A	8	37372	1	.79 x .40 x .43	.20 x .40 x .30	2.95	2.69	2.39	2.15
136549CA	DS4E-M-DC5V*	Aromat	5	4PDT	5VDC	62.5	125VAC/30VDC	.6A/2A	14	112299	2	1.40 x .40 x .36	.20 x .30 x .30	5.49	4.95	4.45	4.05
176313CA	DS4E-M-DC12V	Aromat	5	4PDT	12VDC	360	125VAC/30VDC	.6A/2A	14	112299	2	1.40 x .40 x .36	.20 x .30 x .30	6.95	6.29	5.29	4.39
206543CA	DS4E-S-DC5V-1C-N137	Aromat	6	4PDT	5VDC	125	250VAC/220VDC	2A	14	112299	2	1.40 x .40 x .42	.20 x .30 x .30	8.45	7.77	7.10	6.82
215909CA	RKA-7D2-12	P & B	8	DPST-NO	12VDC	270	250VAC/24VDC	5A/5A	6	—	1	1.13 x .49 x .97	.20 x .80 x .30	2.29	1.95	1.69	1.39

DC Motor Control by Relay

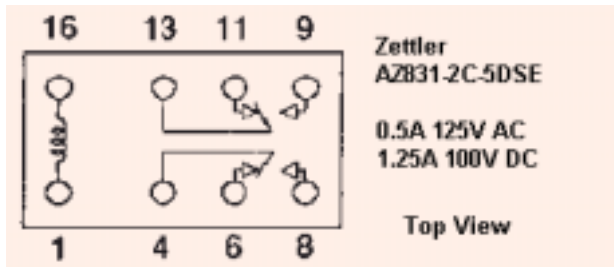
AZ821/AZ831

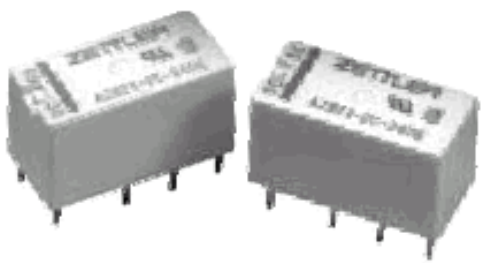
AMERICAN ZETTLER, INC.

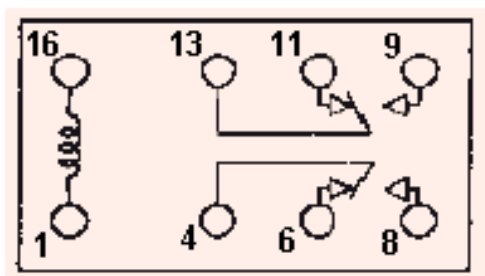
SUBMINIATURE DIP RELAY

FEATURES

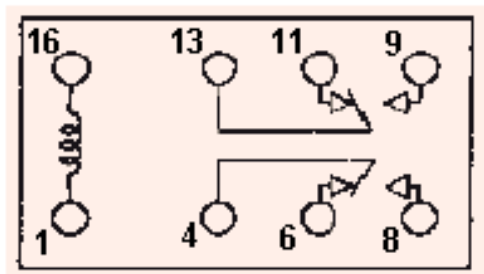
- Low profile for compact board spacing
- DC coils to 48 VDC
- Single button crossbar contacts
- High sensitivity, 100 mW pickup
- Life expectancy to 15 million operations







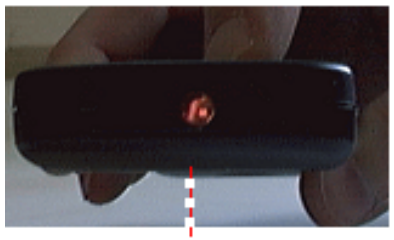
ON/OFF Control

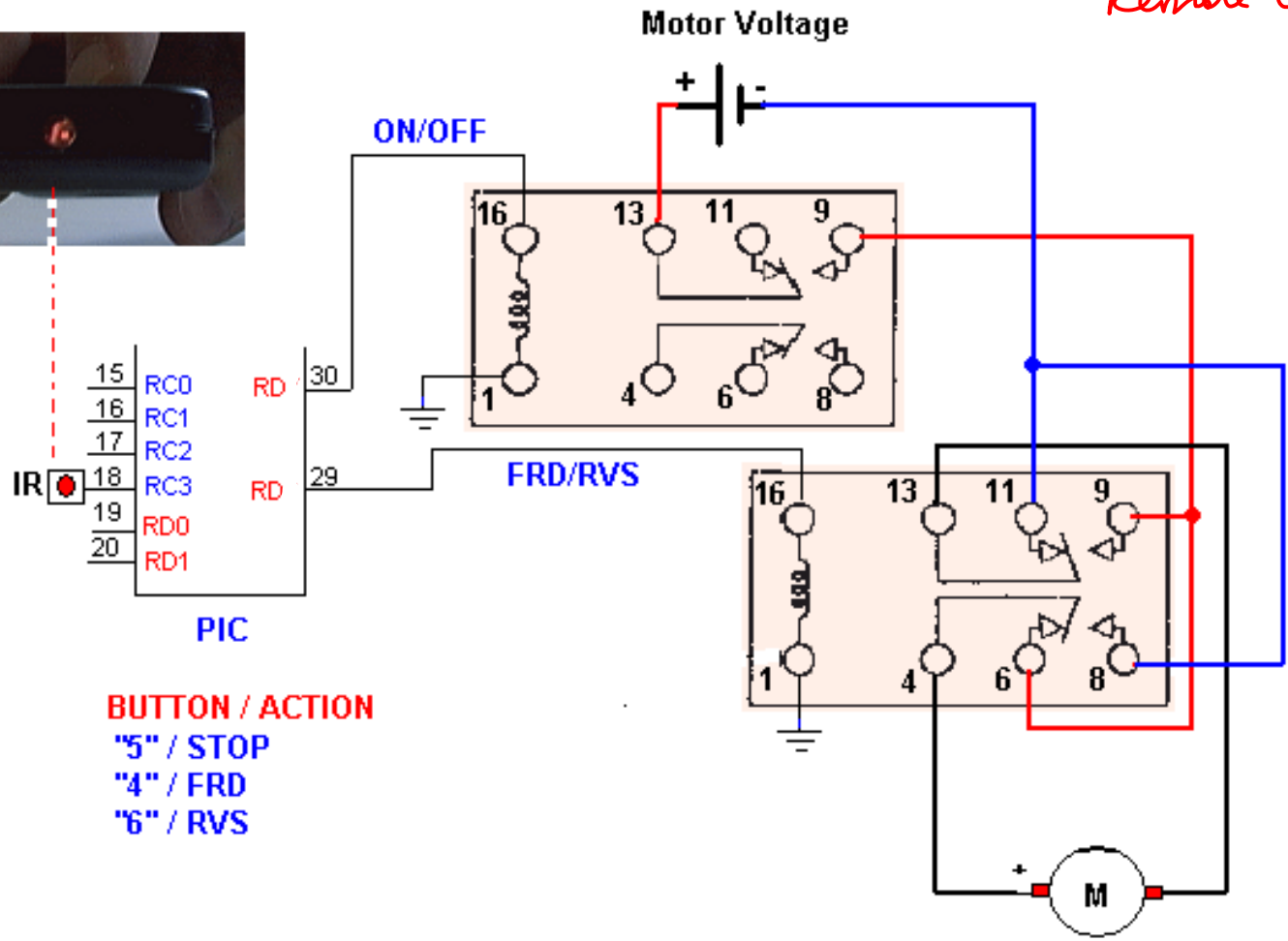


DIRECTION Control

DC Motor Control by Relay

(and with IR Remote Controller)



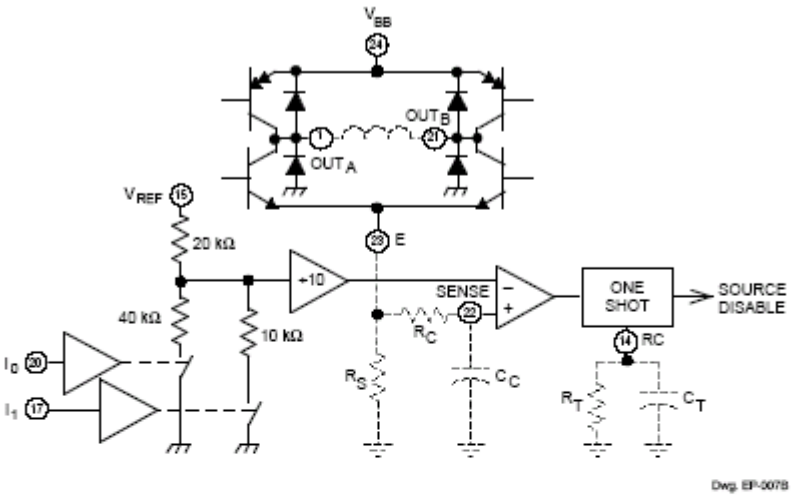


Motor Control using a Relay with IR

```
;RD7 : ON/OFF control
;RD6:  FORWARD/REVSERE DIRECTION
;RD1 : LED for Forward action indicator
;RD0: LED for Reverse action indicator
;RC3: IR receiver
; BUTTON  DECODE VALUE    ACTION          PORTD
;                                         76543210
;=======  ============   ==========      ==========
; 5       4 (00000100)   Stop            00000000
; 4       3 (00000011)   FORWARD              0010
; 6       5 (00000101)   REVERSE              0001
;
;
START
        banksel  TRISC
        movlw    H'28'
        movwf    TRISC
        banksel  TRISD
        crlf     TRISD     ;all output
        banksel  PORTD     ; STOP condition

AGAIN
        call     SONYIR
        clrf     STATUS
        movf     COMreg,0
        andlw    B'11111100'       ;W=3? then FORWARD
        btfss    STATUS, ZERO
        goto     next
        goto     FORWARD
next    movf     COMreg,0
        andlw    B'11111011'       ;W=4? then HOLDON
        btfss    STATUS, ZERO
        goto     next1
        goto     HOLDON
next1   movf     COMreg, 0
        andlw    B'11111010'       ;W=5? then REVERSE
        btfss    STATUS, ZERO
        goto     next2
        goto     REVERSE
next2   goto     AGAIN

;action routine
FORWARD
        banksel  PORTD
        movlw    B'00000010'       ;stop for direction change
        movwf    PORTD
        call     delay1s
        call     delay1s
        banksel  PORTD
        movlw    B'~~10000010~~'   00110010
        movwf    PORTD
        goto     AGAIN
```

DC Motor Control by Allegro 2916

PWM CURRENT-CONTROL CIRCUITRY

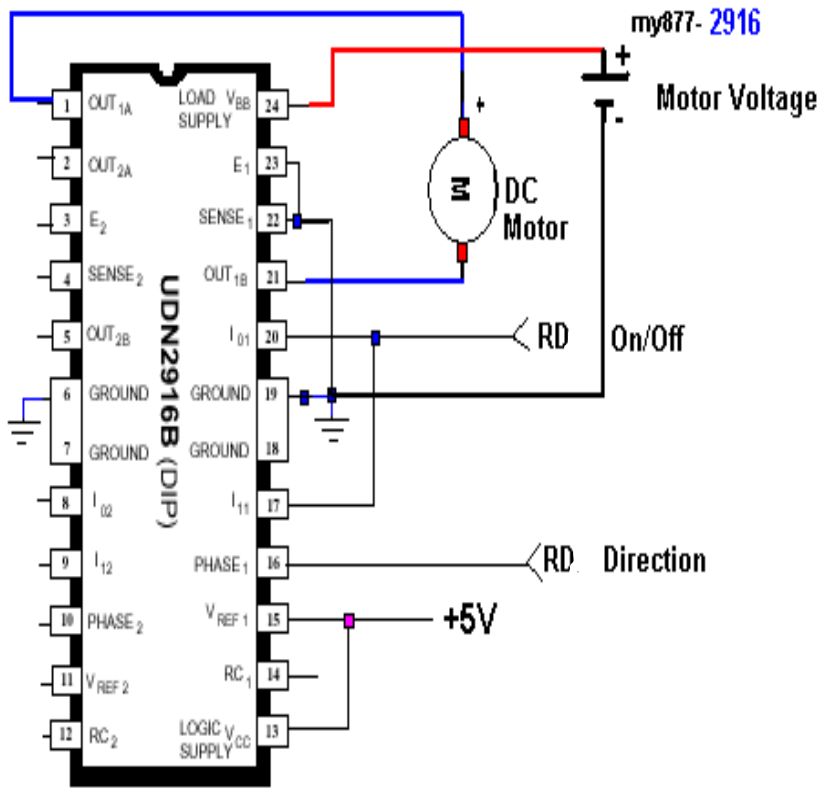


TRUTH TABLE

PHASE	OUT_A	OUT_B
H	H	L
L	L	H

CURRENT-CONTROL TRUTH TABLE

I_0	I_1	Output Current
L	L	$V_{REF}/10\ R_S = I_{TRIP}$
H	L	$V_{REF}/15\ R_S = 2/3\ I_{TRIP}$
L	H	$V_{REF}/30\ R_S = 1/3\ I_{TRIP}$
H	H	0



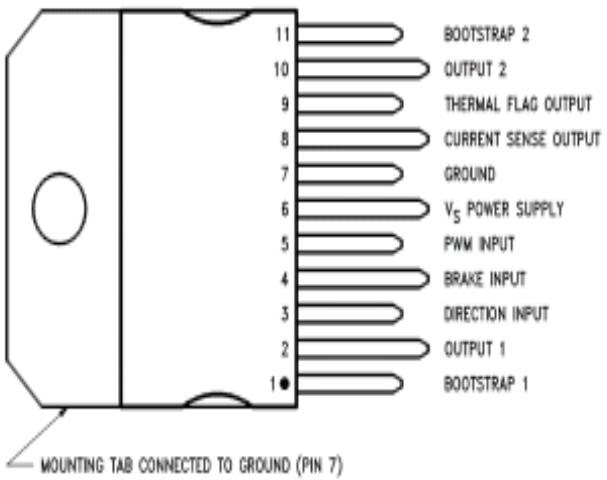
DC Motor Control with UDN2916B: Coding

```
;
;This program is to:
;1. Read Sony Remote Controller
;2. Respond the command of a DC motor to
;    '5': Stop          (IR code: 04)
;    '4': Forward       (IR code: 03)
;    '6': Reverse       (IR code: 05)
;3. Motor Control Chip is ALLEGRO UDN2916B (for Bipolar Stepper & DC control)
;
;
; ON/OFF control is connected to RD7  (Active Low logic)
; DIRECTIOn control is connected to RD6
; LED1 is connected to RD1   (RVS motion indication)
; LED0 is connected to RD0   (FWD motion indication)
;
;

;  SONY IR REading              ACTION          PORTD
;  ===============              ============    7 6 5 4 3 2 1 0 =====
;  04                           STOP            1 X X X X X 0 0   (10000000)
;  03                           ON/FORWARD      0 1 X X X X 1 0   (01000010)
;  05                           ON/REVERSE      0 0 X X X X 0 1   (00000001)
;IR-RX pin(IRX) is dedicated to RC3 port
```

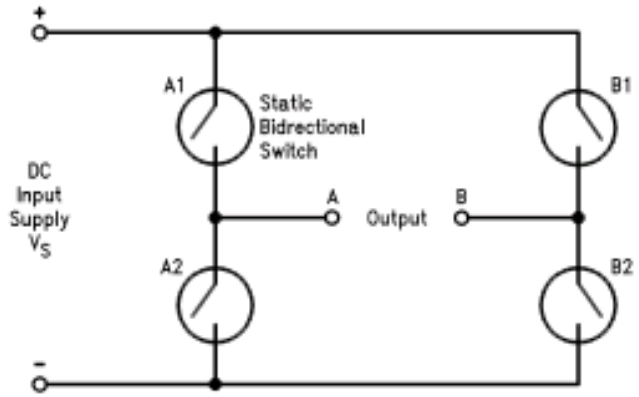
DC Control by H-Bridge Driver LMD18200

National Semiconductor

LMD18200
3A, 55V H-Bridge

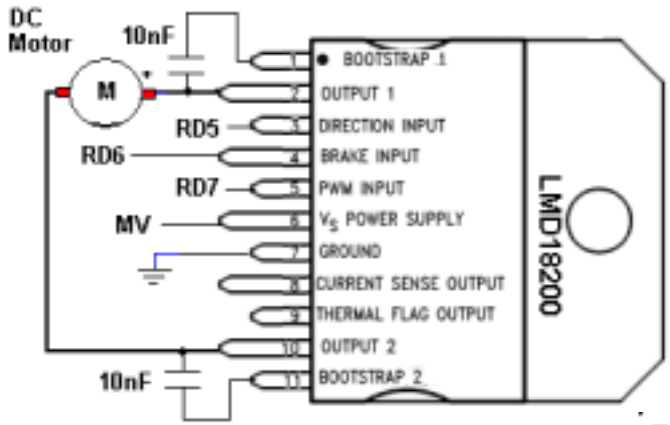


11-Lead TO-220 Package
Top View
Order Number LMD18200T



PWM	Dir	Brake	Active Output Drivers
H	H	L	A1, B2
H	L	L	A2, B1
L	X	L	A1, B1
H	H	H	A1, B1
H	L	H	A2, B2
L	X	H	NONE

LMD18200 – connection and coding (no PWM involved)



PWM	DIR	BRAKE	
H	H	L	FWD
H	L	L	RVS
		H	STOP

STOP before Direction Change

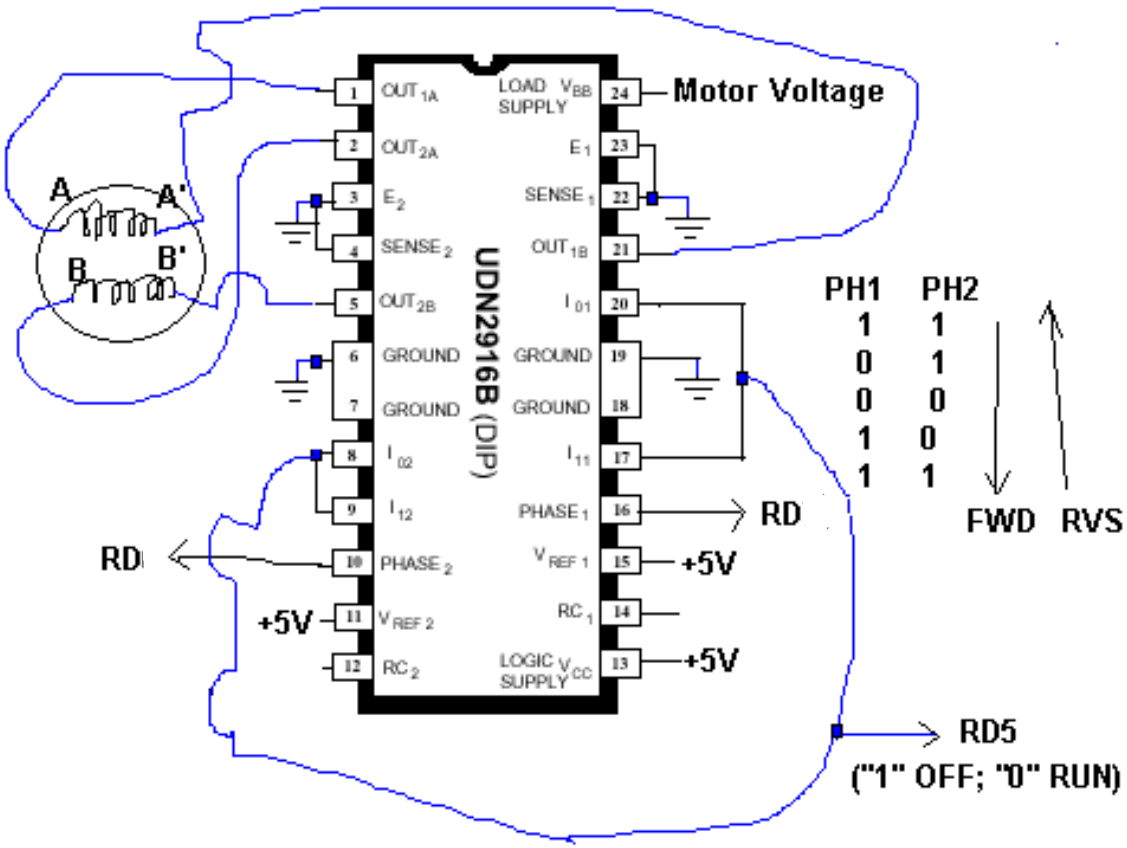
```
;This program is to:
; Control a DC (+12 V or abve) motor using LMD18200
;PWM from PIC is not utilized for this program
;
; PWM is connected to RD7  (Keep High for non-PWM used)
; BREAK is connected to RD6 (H means stop L means Go)
; DIRECTIOn control is connected to RD5  (H for FWD)
; LED1 is connected to RD1   (RVS motion indication)
; LED0 is connected to RD0   (FWD motion indication)
;
;

;    ACTION          PORTD
;   ============     7 6 5 4 3 2 1 0 =====
;  STOP              0 1 0 0 0 0 0 0
;  ON/FORWARD        1 0 1 0 0 0 0 0
;  ON/REVERSE        1 0 0 0 0 0 0 0
;
```

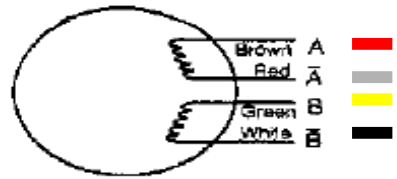
LMD18200 Coding - continued

```
     banksel   TRISD
     movlw     H'00'
     movwf     TRISD           ;All ports ar
     banksel   PORTD
     movlw     B'01000000'
     movwf     PORTD           ;STOP Conditi
AGAIN

; action routine
FORWARD
     banksel   PORTD
     movlw     B'10100010'
     movwf     PORTD
     call      delay10s
     banksel   PORTD
     movlw     B'01100000'
     movwf     PORTD           ;STOP
     call      delay1s
```

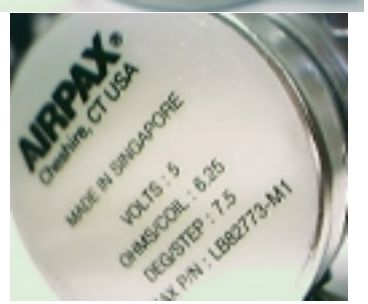
```
REVERSE
     banksel   PORTD
     movlw     B'10000001'
     movwf     PORTD
     call      delay10s
     banksel   PORTD
     movlw     B'01000001'
     movwf     PORTD
     call      delay1s

HOLDON
     banksel   PORTD
     movlw     B'01000000'
     movwf     PORTD
     call      delay1s         ;at
     call      delay1s
     call      delay1s
     goto      AGAIN
```

Bipolar Stepper Control using UDN2916B



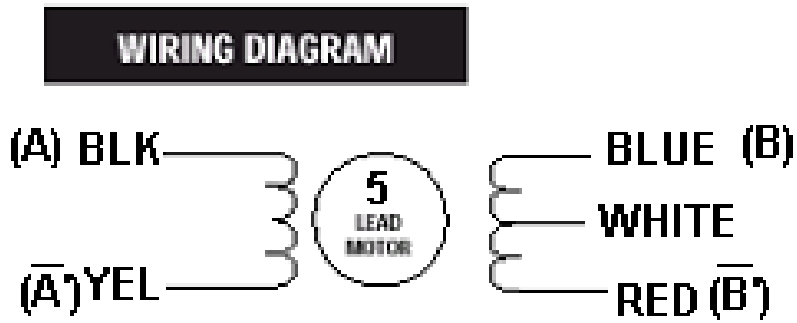


Step	A	B	Ā	B̄
1	+	+	-	-
2	-	+	+	-
3	-	-	+	+
4	+	-	-	+
5	+	+	-	-



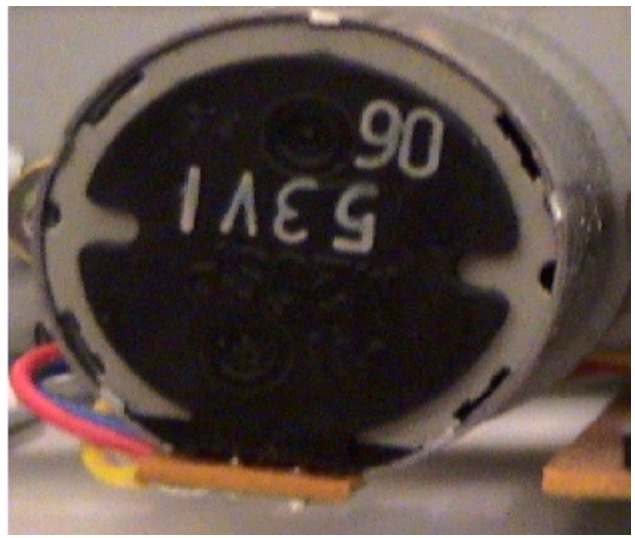
Note on a Symbol Motor

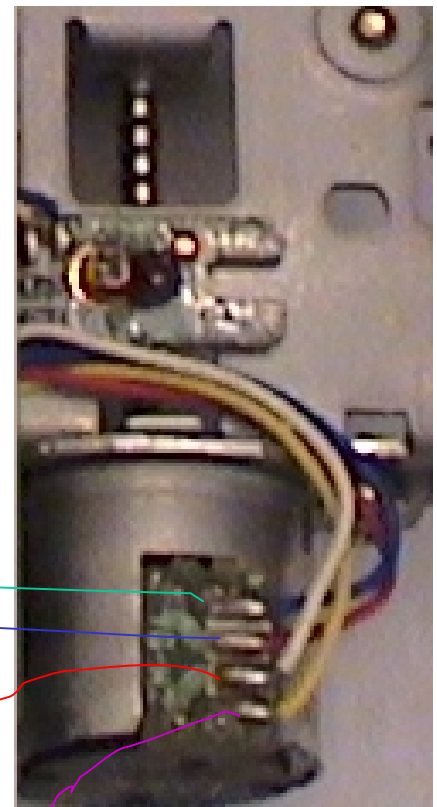
Symbol Technologies 21-02485 Bipolar Motor

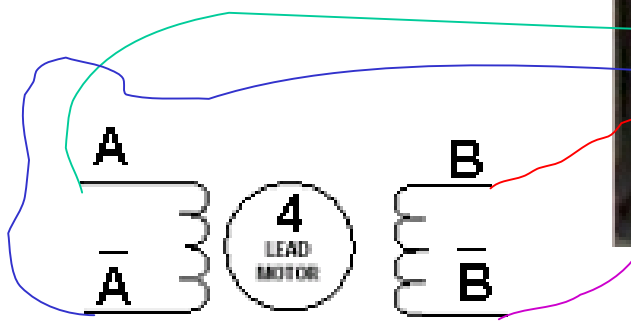


*NOTE: If the motor comes with WHITE and BLACK wires tied together, cut the White wire from the connector. WHITE is not used in Bipolar mode.

Floppy Disk Driver Head Motor







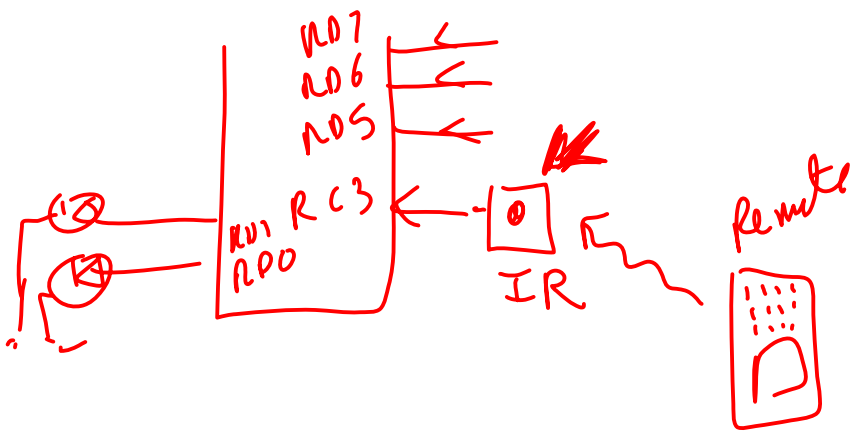
Forward/Reverse Sequennce

```
;To generate forward sequence of 4 pulses
;to move the rotor forward 4 steps
fSequence
    banksel PORTD
    bcf PORTD, 0x05     ;100% power START
    call    delay100ms
    movlw   B'11000010'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'01000010'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'00000010'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'10000010'
    movwf   PORTD
    call    delay100ms
    movlw   B'11000000'
    movwf   PORTD
    return
```

```
;To generate forward sequence of 4 pulses
;to move the rotor backward 4 steps
rSequence
    banksel PORTD
    bcf PORTD, 0x05
    call    delay100ms
    movlw   B'11000001'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'10000001'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'00000001'
    movwf   PORTD
    call    delay100ms
    banksel PORTD
    movlw   B'01000001'
    movwf   PORTD
    call    delay100ms
    movlw   B'11000000'
    movwf   PORTD
    return
```

Bipolar Stepper Motor Coding – with SONY IR

```
;This program is to:
;1. Read Sony Remote Controller
;2. Respond the command of a Bipolar Stepper motor to
;     '5': STOP              (IR code:04)
;     '4': Forward           (IR code: 03)
;     '6': Reverse           (IR code: 05)
;3. Motor Control Chip is ALLEGRO UDN2916B (for Bipolar Stepper &
DC control)
;
;
; Phase 1 control (for A and A- coil) is connected to RD7
; Phase 2 control (for B and B- coil) is connected to RD6
; PWM control lines (I01, I02, I11, and I12) are tied to RD5
; LED1 is connected to RD1    (RVS motion indication)
; LED0 is connected to RD0    (FWD motion indication)
;
;

;  SONY IR REading  ACTION          PORTD
;  ===============      ===========      76543210 =====
;  04               STOP               (00100000)
;  03               ON/FORWARD STEPS   See below
;  05               ON/REVERSE STEPS   See below
;IR-RX pin(IRX) is dedicated to RC3 port
```




```
;  1 STEP FORWARD
;    A   B        7 6 5 4 3 2 1 0  (PORTD)
;    +   +    --->1 1 0 0 0 0 1 0
;    -   +    --->0 1 0 0 0 0 1 0
;    -   -    --->0 0 0 0 0 0 1 0
;    +   -    --->1 0 0 0 0 0 1 0
;
;  1 STEP REVERSE
;    A   B        7 6 5 4 3 2 1 0  (PORTD)
;    +   +    --->1 1 0 0 0 0 0 1
;    +   -    --->1 0 0 0 0 0 0 1
;    -   -    --->0 0 0 0 0 0 0 1
;    -   +    --->0 1 0 0 0 0 0 1
```

Coding - Continued

```
;blah blah
;====================================
          banksel   PORTD
          movlw     B'11100000'
          movwf     PORTD           ;STOP
AGAIN
          call SONYIR
          call IRdecoding
;blah blah
;============================
FORWARDSTEP
          banksel   PORTD
          bcf  PORTD, 0x05
          banksel   first

          movlw     H'05'
          movwf     first
fagain    call      fSTEP
          decfsz    first
          goto      fagain
          banksel   PORTD
          movlw     B'11100000'
          movwf     PORTD
          goto      AGAIN

REVERSESTEP
          banksel   PORTD
          bcf  PORTD,0x05
          banksel   second
          movlw     H'05'
          movwf     second
ragain    call      rSTEP
          decfsz    second
          goto      ragain
          banksel   PORTD
          movlw     B'11100000'
          movwf     PORTD
          goto      AGAIN
```

```
HOLDON
          banksel   PORTD
          movlw     B'11100000'
          movwf     PORTD
          call      delay1s         ;at least
          goto      AGAIN
;
;blah
;======================
fSTEP
          banksel   PORTD
          movlw     B'11000010'
          movwf     PORTD
          call      delay200ms
          banksel   PORTD
          movlw     B'01000010'
          movwf     PORTD
          call      delay200ms
          banksel   PORTD
          movlw     B'00000010'
          movwf     PORTD
          call      delay200ms
          banksel   PORTD
          movlw     B'10000010'
          movwf     PORTD
          call      delay200ms
          return
;======================================
```

Unipolar Control using UCN5804

Allegro MicroSystems, Inc.

5804

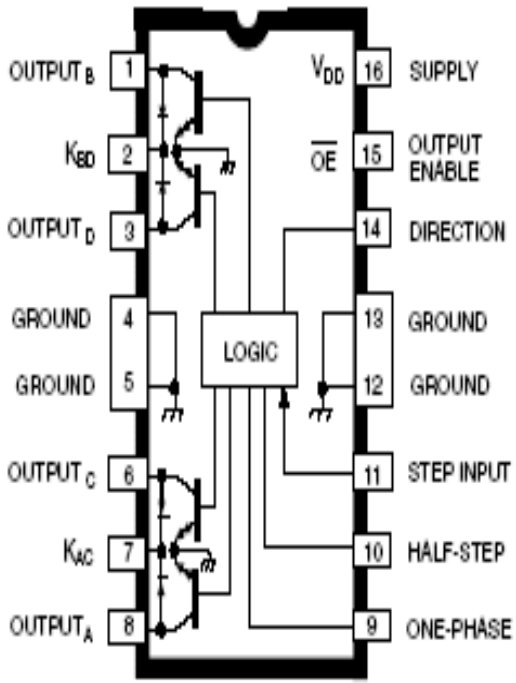
UCN5804B

FEATURES

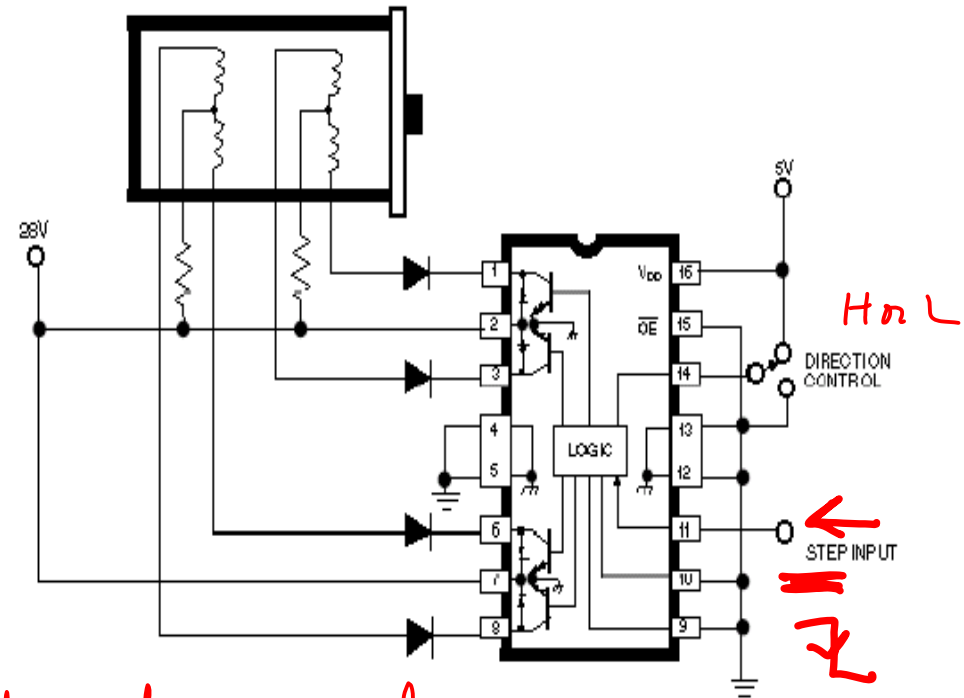
- 1.5 A Maximum Output Current
- 35 V Output Sustaining Voltage

UNIPOLAR STEPPER-MOTOR DRIVER

Single Pulse control

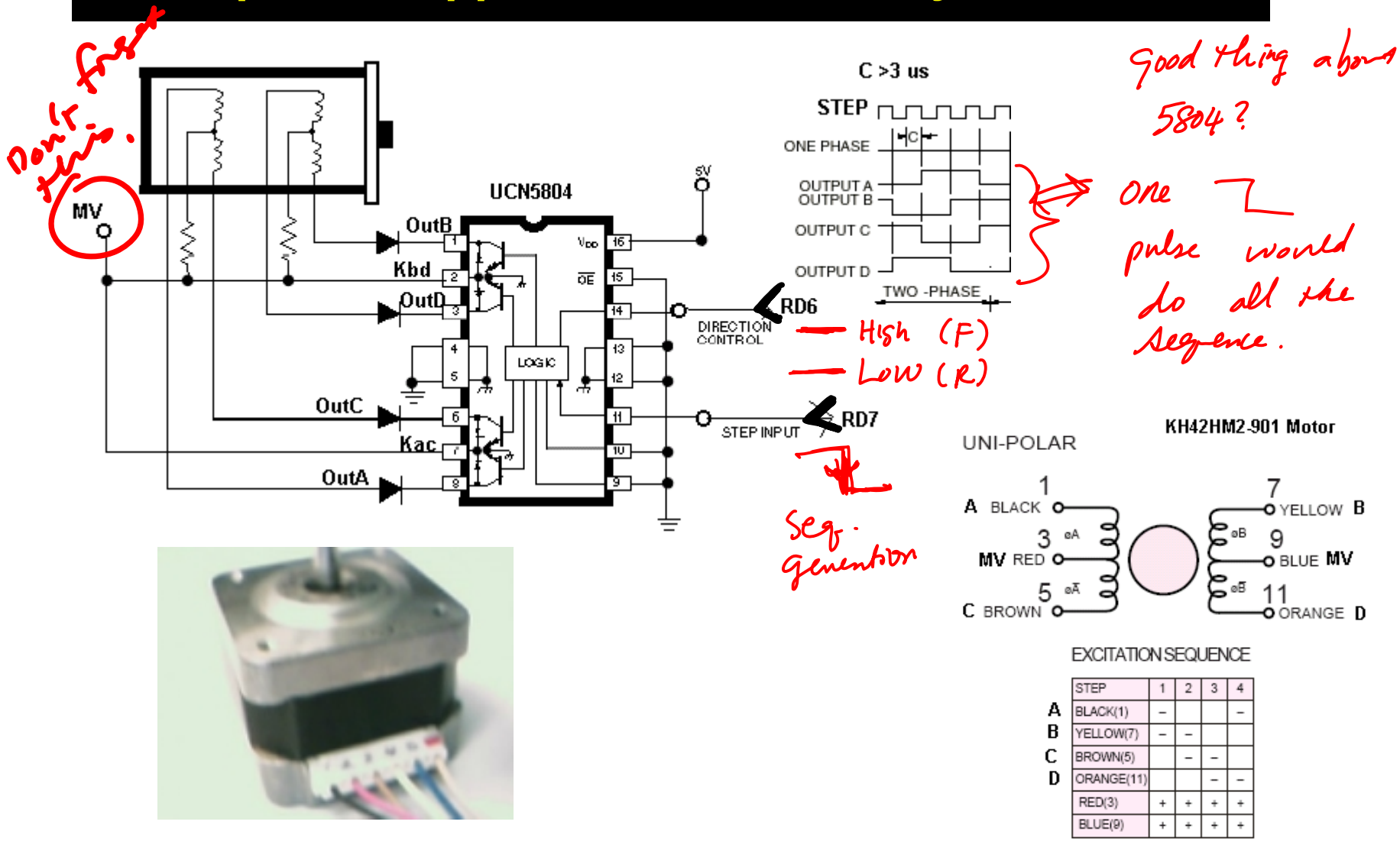


TYPICAL APPLICATION
L/R Stepper-Motor Drive



Direction change, only when STEP input is Low

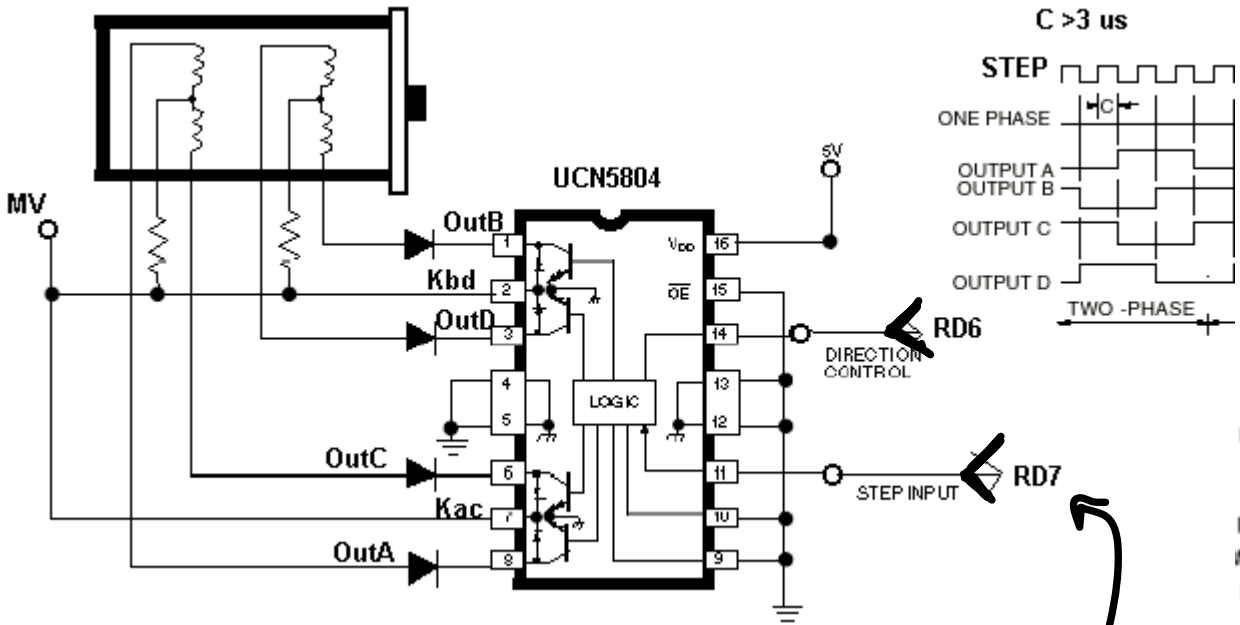
Unipolar Stepper Motor Control by UCN5804



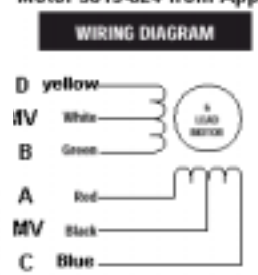
EXCITATION SEQUENCE

	STEP	1	2	3	4
A	BLACK(1)	–			–
B	YELLOW(7)	–	–		
C	BROWN(5)		–	–	
D	ORANGE(11)			–	–
	RED(3)	+	+	+	+
	BLUE(9)	+	+	+	+

Unipolar Stepper Motor Control by UCN5804



Motor 5015-824 from Applied Motoin Products



STEP TABLE

STEP	RED	BLU	GRN	YEL
0	ON	OFF	ON	OFF
1	OFF	ON	ON	OFF
2	OFF	ON	OFF	ON
3	ON	OFF	OFF	ON
	A	C	B	D

Coding for UCN5804

```
;This program is to:
;1. Control a Unipolar Stepper Motor
;2. Turn Forward then Reverse
;3. Motor Control Chip is ALLEGRO UCN5804 (for Unipol
control)
;
;
; HIGH-To-LOW PULSE output connected to RD7
; DIRECTION output is connected to RD6
;
; LED1 is connected to RD1    (RVS motion indication)
; LED0 is connected to RD0    (FWD motion indication)
;
;
;  ACTION            PORTD
;
;  1 STEP FORWARD: set RD6 H    then  H --> L of RD7
;  1 STEP REVERSE: set RD6 L    then  H --> L of RD7
;   To change the direction, RD7 must be in L state
```

```
FORWARDSTEP
            banksel   PORTD
            bsf       PORTD, FR ;forward
            bsf       PORTD, LED1     ;forward indicator
            bcf       PORTD, LED0
            banksel   first
            movlw     H'14'
            movwf     first
fagain      call      PULSE
            decfsz    first
            goto      fagain
            banksel   PORTD
            movlw     B'00000000'
```

06

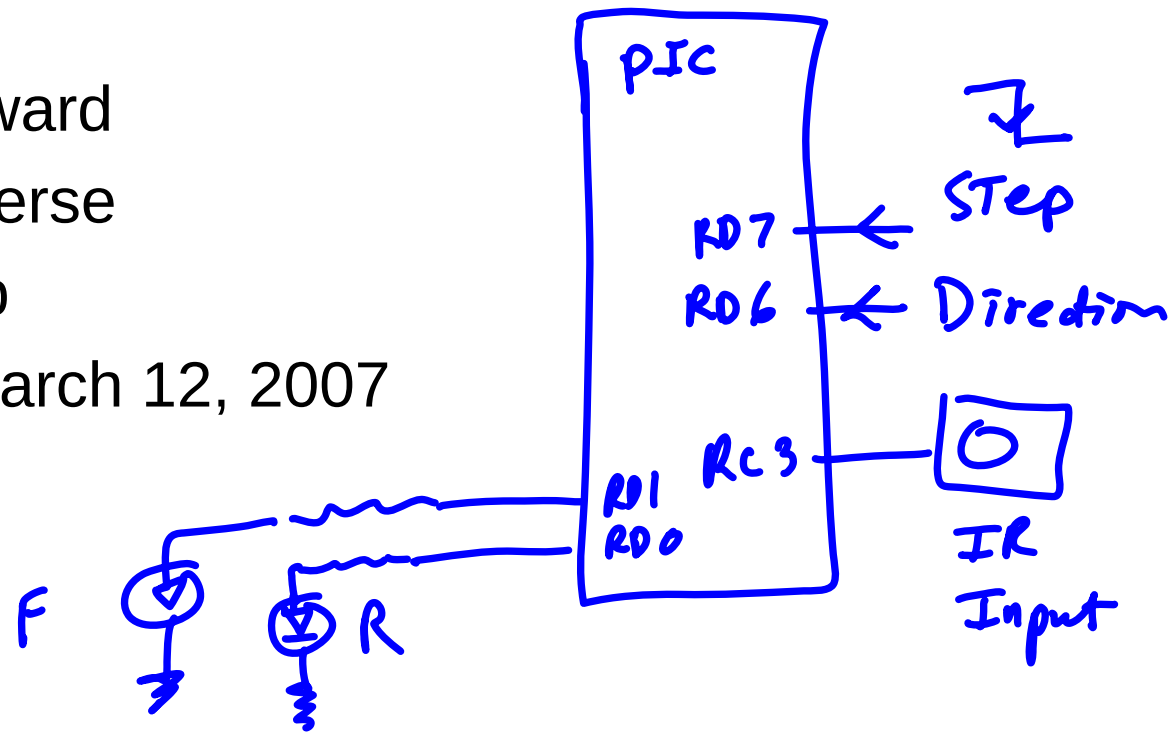
2/4/8 or any # of pulses or steps

```
; ====== subroutine PULSE ======
PULSE
            banksel   PORTD
            bsf       PORTD, STEP     ;RD7
            call      delay10ms       ;or 20ms 0r 200ms etc
            banksel   PORTD
            bcf       PORTD, STEP
            call      delay10ms
            return
```

07

Assignment for Unipolar using UCN5804

- Add SONY IR into UCN 5804 control of a Unipolar Motor
- Button 2 for Forward
- Button 8 for Reverse
- Button 5 for Stop
- Due: Monday, March 12, 2007
  - Class Check

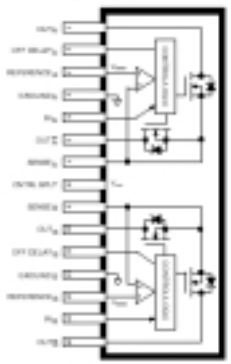


Unipolar Stepper Control using SLA7024

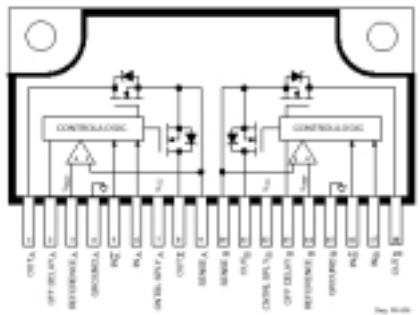
HIGH-CURRENT PWM, UNIPOLAR STEPPER MOTOR CONTROLLER/DRIVERS

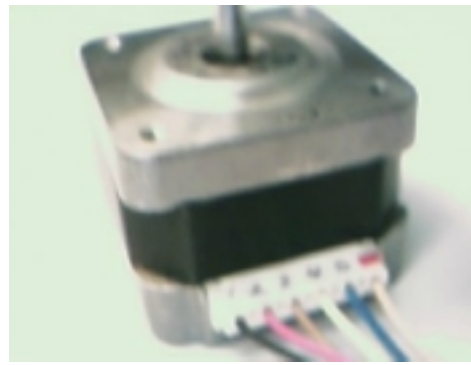
Part Number	Package	Output Current
SLA7024M	18-Lead Power-Tab SIP	1.5 A
SLA7026M	18-Lead Power-Tab SIP	3.0 A
SMA7029M	15-Lead SIP	1.5 A

SMA7029M



SLA7024M and SLA7026M





2-PHASE (FULL STEP) OPERATION for SLA7024M and SLA7026M

Sequence	0	1	2	3	0
Input A	H	L	L	H	H
Input $\overline{A}$	L	H	H	L	L
Input B	H	H	L	L	H
Input $\overline{B}$	L	L	H	H	L
Outputs ON	AB	$\overline{A}$ B	$\overline{AB}$	A $\overline{B}$	AB