

# AA2020A, AA2820 BILEVEL STEP MOTOR DRIVER CONTROLLER ICs



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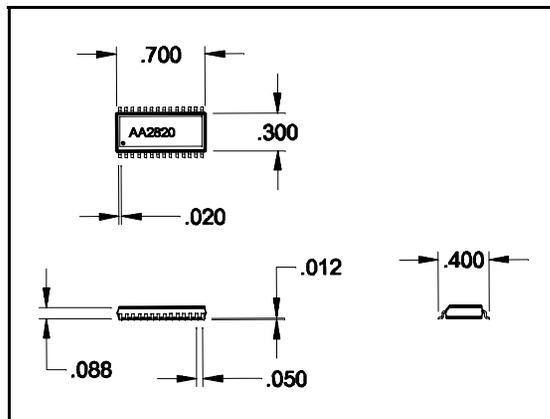
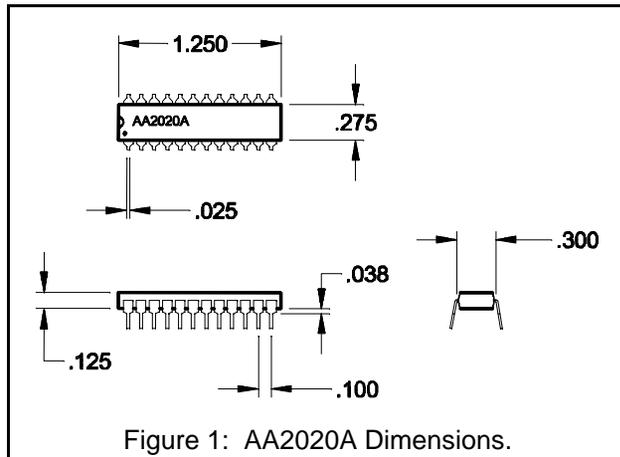
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## DESCRIPTION

The AA2020A and AA2820 are CMOS integrated circuits that are ideally suited for the design of 4-phase unipolar and bipolar step motor drivers. These IC's can be used to design **half-step** and **full-step** bilevel type drivers.

The basic function of these ICs is to take input (i.e. clock and direction) signals and turn them into appropriate phase signals that are used to drive output transistors. In most applications, the end user simply adds a few components along with power transistors for the output stage. This results in low cost, compact, and reliable designs.

The AA2020 comes in a 24-pin plastic DIP package. The AA2820 comes in a 28-pin SOIC package. See dimensions below.



## SPECIFICATIONS

PARAMETER	SYMBOL	LIMITS			UNITS
		MIN	TYP.	MAX	
Supply Voltage	Vdd	4.75	5.00	5.25	V
Input Voltage	Vin	3.5	-	5.00	V
Operating Temperature (Ambient)	Ta	0	-	70	C
Storage Temperature	Ts	0	-	70	C
Power Dissipation			250		mW
Supply current			50		mA
Min. clock Pulse Width	twh, twl		15		usec
Propagation Delay Time (Clock to Output)	tpd	3.5		5	sec
Oscillator Frequency	Fosc	800	1000	1200	kHz
Rise Time	tr	1			usec
Fall Time	tf	1			usec

## TYPICAL OUTPUT CHARACTERISTICS

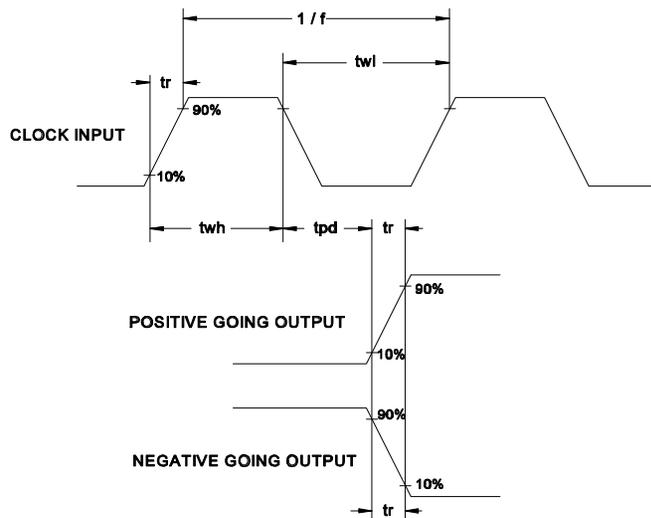
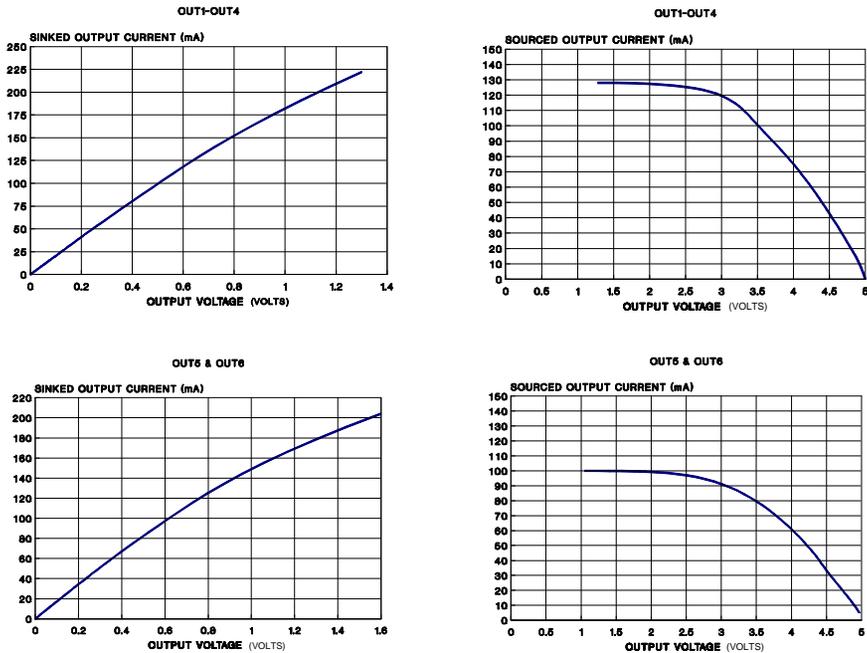


Figure 3: Input/Output Waveform Characteristics

## BILEVEL DRIVE

The basic function of a step motor driver is to control the motor winding currents. Motor performance is determined by how fast the driver can increase and decrease the winding currents. A rapid rise in winding current is achieved by applying a high voltage directly to a motor. This rapid rise of current is also referred to as the "kick" or operating current. When a desired current level is reached, a low voltage is applied to maintain a suitable holding current level. When a motor winding is turned off, a rapid decrease in winding current is achieved by routing the energy in the collapsing field back to the power supply through a high voltage path. The high voltage supply furnishes the energy necessary to maintain motor output torque at high step rates thus providing high mechanical power output. The low voltage supply provides much of the current needed at low step rates and all of the holding current.

The efficiency of bilevel drive makes for step motor performance that is far superior to that produced by L/R drives. Also, bilevel drivers do not use high frequency switching techniques as chopper drivers do. Consequently, they do not create the EMI, RFI, and motor heating problems that are associated with chopper drivers.

### AA2020 Operation

Each time the chip receives a clock signal, the phase outputs change state. When a phase output turns on, a high voltage output also turns on. This high voltage output is used to turn on a high-side switch. The high voltage output will stay on until the chip gets a reset signal. In Figure 4, OUT1 turns on when the CLOCK input goes low. OUT5 turns on at the same time. OUT5 stays on until the reset input, R13 goes low. The waveforms in Figure 4 are for half-step operation. In half-step operation, the phase outputs are on for three clock cycles. The high voltage output will turn on the first two of these cycles. If the reset input never goes low, the high voltage output will stay on. In full-step operation, each phase output is on for two clock cycles and the corresponding high voltage output will turn on at the beginning of each clock cycle.

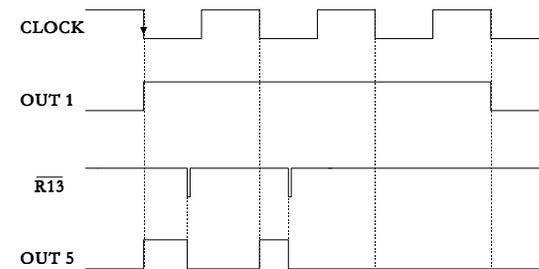


Figure 4: High Voltage Output (OUT5) vs. Reset (R13) and OUT1.

## AA2020A PIN DESCRIPTION

<u>PIN</u>	<u>NAME</u>	<u>DESCRIPTION</u>
1	Vdd	Power (+5Vdc)
2	Vdd	Power (+5Vdc)
3	OP	Output Polarity - When this input is logic "1", positive true phase outputs are selected. When this input is logic "0", negative true phase outputs are selected. Only OUT1-OUT4 are affected. OUT5 and OUT6 are always positive true.
4	OUT 5	High Voltage output signal for phase 1 and phase 3. This output is used to turn on a high-side switch for phases 1 and 3. This output goes high every time phase 1 or 3 turns on. This output can only be turned off when R13 goes low.
5	IN 2	CCW input (Phase 2 input) - Pulses applied to this input cause the chip to sequence in the counterclockwise direction. This input is Phase 2 In when using phase inputs.
6	OUT 1	Phase 1 output
7	OUT 3	Phase 3 output
8	IN 4	Half-step/Full-step (Phase 4 input) - A logic "1" on this input selects half-step operation when using Clock inputs. A logic "0" on this input select full-step operation. This input is Phase 4 IN when using phase inputs.
9	OSC IN	Oscillator Input - see section on oscillator.
10	OSC OUT	Oscillator Output - see section on oscillator.
11	PRESET	Preset for power up - see section on PRESET
12	Vss	0Vdc
13	Vdd	Power (+5Vdc)
14	ON/OFF	Motor ON/OFF -A logic "1" on this input allows the to function normally. A logic "0" on this inputs turns off all outputs.
15	OUT 6	High Voltage signal for phase 2 and phase 4. This output is used to turn on a high-side switch for phases 2 and 4. This output goes high every time phase 2 or 4 turns on. This output can only be turned off when R24 goes low.
16	R	Reset input for phase 1 and phase 3 high voltage - when this input goes low, OUT5 turns off.
17	R24	Reset input for phase 2 and phase 4 high voltage - when this input goes low, OUT6 turns off.
18	OUT 4	Phase 4 output
19	OUT 2	Phase 2 output
20	IN 3	Direction/ Phase 3 input - A logic "1" on this input selects clockwise direction when using Clock inputs. A logic "0" on this input selects counterclockwise direction when using Clock inputs. This input is Phase 3 IN when using Phase inputs.
21	C/P	Clock/Phase Inputs - A logic "1" on this input selects Clock inputs. A logic "0" on this input selects Phase inputs.
22	IP	Input Polarity - A logic "1" on this input selects negative going Clock inputs or negative true phase inputs. A logic "0" on this input selects positive going Clock inputs or positive true phase inputs.
23	IN 1	Clock In/ Phase 1 input - Pulses applied to this input cause the chip to sequence in the clockwise direction when using Clock inputs. This input is Phase 1 IN when using Phase inputs.
24	Vss	0Vdc

## AA2820 PIN DESCRIPTION

PIN	NAME	DESCRIPTION
1	Vdd	Power (+5Vdc)
2	<b>HV OFF</b>	turns high voltage off when logic "0". This does not reset the high voltage outputs.
3	Vdd	Power (+5Vdc)
4	OP	Output Polarity
5	OUT 5	high voltage output for phase 1 and phase 3
6	IN 2	CCW input/ Phase 2 input
7	OUT 1	Phase 1 output
8	OUT 3	Phase 3 output
9	IN4	Half-step/Full-step/ Phase 4 input
10	OSC IN	Oscillator Input
11	OSC OUT	Oscillator Output
12	PRESET	Preset for power up
13	<b>OUT56</b>	this output is a logic "1" when both OUT5 and OUT6 are logic "1"
14	Vss	0Vdc
15	Vdd	Power (+5Vdc)
16	<b>RUN/STOP</b>	When this input is a logic "0" all clocking is ignored
17	ON/OFF	Motor ON/OFF
18	OUT 6	high voltage output for phase 2 and phase 4
19	R13	reset for phase 1 and phase 3 high voltage
20	R24	reset for phase 2 and phase 4 high voltage
21	OUT 4	Phase 4 output
22	OUT 2	Phase 2 output
23	IN3	Direction/ Phase 3 input
24	C/P	Clock/Phase mode
25	IP	Input polarity
26	IN 1	Clock In/ Phase 1 input
27	<b>CLOCK OUT</b>	this output gives a pulse for each pulse on the clock input or for each phase change when using phase inputs
28	Vss	0Vdc

Inputs in **BOLD** are available only on the AA2820 SOIC.

## OSCILLATOR

The oscillator frequency must be set at 800kHz to 1.2MHz because of internal timing. It is strongly recommended to use the resistor and capacitor values shown in Figure 5. These values will produce an oscillator frequency of about 1 Mhz.

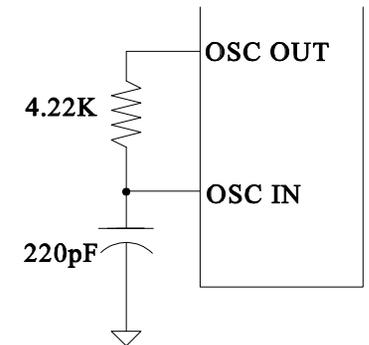


Figure 5: Oscillator R and C values.

The PRESET pin must be held at logic "0" upon power up until the supply for the chip reaches +5V. It is recommended to use the PRESET circuit shown in Figure 6. When the PRESET pin is held at logic "0", all outputs are off (logic "0"). When the PRESET pin goes high, the chip comes up in it's preset condition. In half-step mode, phase 1 will be on. In full-step mode, phase 1 and phase 2 will be on.

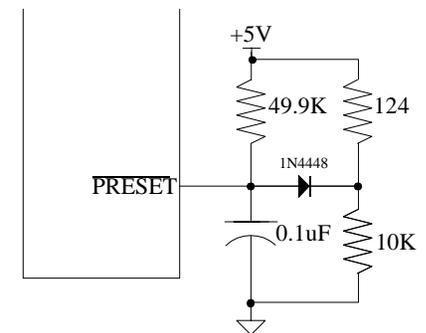


Figure 6: Preset Circuit.

# CLOCK INPUT SELECTION

There are three three clocking methods for the AA2020A and AA2820. The C/P input is used to select CLOCK inputs or PHASE inputs. The IP input is used to select positive or negative going inputs. See Table 1.

INPUT CLOCK SELECTION	C/P	IP
+ GOING CLOCK INPUTS	1	0
- GOING CLOCK INPUTS	1	1
POSITIVE TRUE PHASE INPUTS	0	0
NEGATIVE TRUE PHASE INPUTS	0	1

TABLE 1: CLOCK INPUT SELECTION.

**CLOCK and DIRECTION:** Pulses applied to the CLOCK input will cause the motor to step in the clockwise direction if the DIRECTION input is logic "1". Pulses applied to the CLOCK input will cause the motor to step in the counterclockwise direction if the DIRECTION input is logic "0". Figure 7 shows Clock and Direction signals which will make 5 steps in the clockwise direction and 5 steps in the counterclockwise direction.

**CLOCK and CCW:** Pulses applied to the CLOCK input cause the motor to step in the clockwise direction. Pulses applied to the CCW input cause the motor to step in the counterclockwise direction. Pulses should NOT be applied to both of these inputs at the same time. The input which is not being used should be held low when using positive going clock inputs, or held high when using negative going clock inputs. Figure 7 shows Clock and Direction signals which will make 5 steps in the clockwise direction and 5 steps in the counterclockwise direction.

**PHASE INPUTS:** Half-step or Full-step sequence phase inputs may be used to synchronize multiple axes. Only the phase input sequences shown in Figure 8 may be used. The phase input sequences in figure 4 produce clockwise motor movement. The phases may be reversed to obtain counterclockwise motor movement. Positive or Negative true phase inputs may be used.

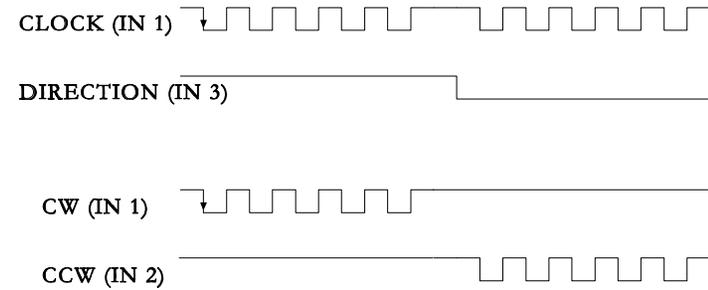


Figure 7: The CLOCK and DIRECTION signals are equivalent to the CW and CCW signals

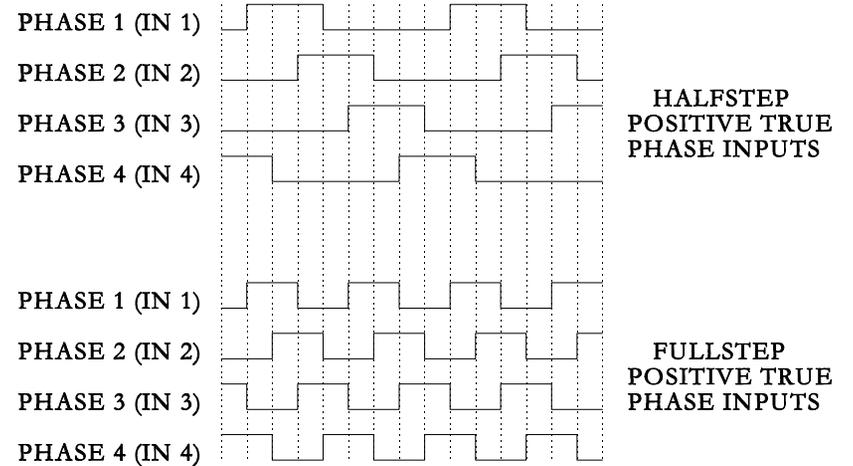


Figure 8: PHASE INPUT SEQUENCE

## HALF-STEP/FULL-STEP

The AA2020A and AA2820 can operate a motor in half-step or full-step operation. In half-step mode, the motor is stepped by alternately energizing one phase, and then two phases of the motor. With a 1.8 degree motor (200 steps/rev), half-step mode will provide 400 steps/revolution. Table 2 below shows the sequence for half-step.

PHASE 1	PHASE 2	PHASE 3	PHASE 4	
1	0	0	0	CC W
1	1	0	0	
0	1	0	0	CW
0	1	1	0	
0	0	1	0	CW
0	0	1	1	
0	0	0	1	CW
1	0	0	1	

Table 2: Half-step Phase Sequence 1=ON, 0=OFF

In Full-step mode, there are always two phases on at a time. The motor is stepped by turning off a phase and turning on the opposite phase (i.e. - turn phase 1 off and turn phase 3 on). A standard 1.8 degree motor will provide 200 steps/revolution in full-step mode. The phase sequence for full-step is shown in figure y2.

PHASE 1	PHASE 2	PHASE 3	PHASE 4	
1	1	0	0	CC W
0	1	1	0	
0	0	1	1	CW
1	0	0	1	

Table 3: Full-step Phase Sequence 1=ON, 0=OFF

## CONNECTION DIAGRAM

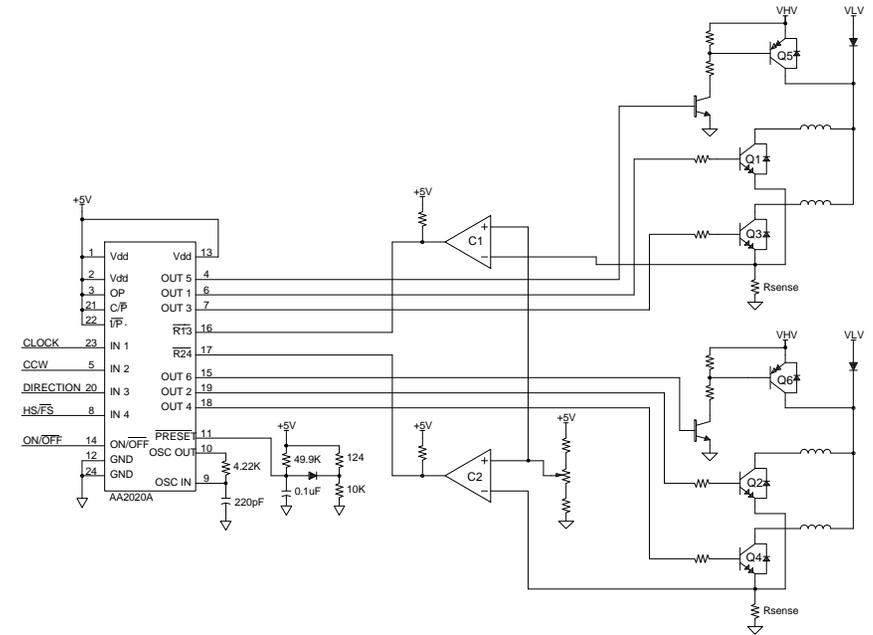


Figure 9: Typical hookup for unipolar bilevel step motor driver using AA2020A.

Figure 9 shows a typical hookup with the AA2020A chip. Q1-Q4 are npn darlington transistors used for the 4 phase outputs. Q5 and Q6 are pnp darlington transistors used as high-side switches. The Rsense resistors are used to sense the current flowing through the motor. When the current in phase 1 or 3 reaches a level set by the potentiometer, comparator C1 goes low (logic "0") and resets (turns off) OUT5. The same thing happens for phase 2 and 4.