



a Penn Central unit

INTEGRATED CIRCUIT
ENGINEERING BULLETIN

UCN-4202A
UCN-4203A

UCN-4202A AND UCN-4203A STEPPER-MOTOR TRANSLATORS AND DRIVERS

FEATURES

- 600 mA Output Current
- Full-Step or Double-Step Operation
- Single-Input Direction Control
- Power-On Reset
- Internal Transient Suppression
- Schmitt Trigger Inputs

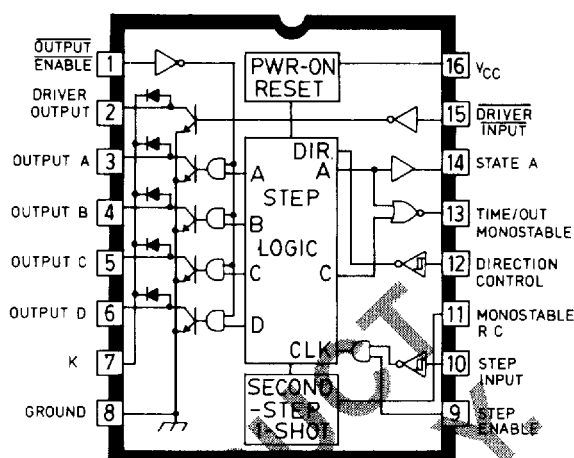
DESIGNED TO DRIVE permanent-magnet stepper motors with current ratings of up to 500 mA, these integrated circuits employ a full-step, double-pulse drive scheme that allows use of up to 90 percent of available motor torque. The two devices differ only in output-voltage ratings: Type UCN-4202A has a 20 V breakdown-voltage rating and a 15 V sustaining voltage rating; Type UCN-4203A has a 50 V breakdown-voltage rating and a 35 V sustaining voltage rating.

Both drivers are bipolar I²L designs containing approximately 100 logic gates, TTL-compatible input/output circuitry, and 600 mA outputs with internal transient suppressors. The devices operate with a minimum of external components.

The four-phase stepper-motor load is controlled by step-logic functions. To step the load from one position to the next, STEP INPUT is pulled down to a logic low for at least 1 μ s, then allowed to return to a logic high. The step logic is activated on the positive-going edge, which in turn activates one of the four current-sink outputs. DIRECTION CONTROL determines the sequence of states (A-B-C-D or A-D-C-B).

In the full-step mode, the MONOSTABLE RC timing pin is tied to V_{CC} , making states B and D stationary. A separate input pulse is required to move through each of the four output states.

In the double-step mode, states B and D are transition states with duration determined by MONOSTABLE RC timing. Improved motor torque is ob-



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tained at double the nominal motor step angle, and motor stability is improved for high step rates.

Higher current ratings, or bipolar operation, can be obtained by using Type UCN-4202A or UCN-4203A as a logic translator to drive integrated motor drivers (Sprague Type UDN-2949Z or UDN-2952B/W) or discrete high-power transistors.

ABSOLUTE MAXIMUM RATINGS at $T_A = +25^\circ\text{C}$

| | |
|---|---|
| Supply Voltage, V_{CC} | 7.0 V |
| V_K (UCN-4202A) | 20 V |
| (UCN-4203A) | 50 V |
| Output Voltage, V_{OUT} (UCN-4202A) | 20 V |
| (UCN-4203A) | 50 V |
| Input Voltage, V_{IN} | 7.0 V |
| Output Sink Current, I_{OUT} | 600 mA |
| Power Dissipation, P_D (One Driver) | 0.8 W |
| (Total Package) | 2.0 W* |
| Operating Temperature Range, T_A | -20°C to $+85^\circ\text{C}$ |
| Storage Temperature Range, T_S | -55°C to $+150^\circ\text{C}$ |
| Derate at the rate of 16.6 mW/ $^\circ\text{C}$ above $+25^\circ\text{C}$. | |

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STEPPER-MOTOR TRANSLATORS AND DRIVERS

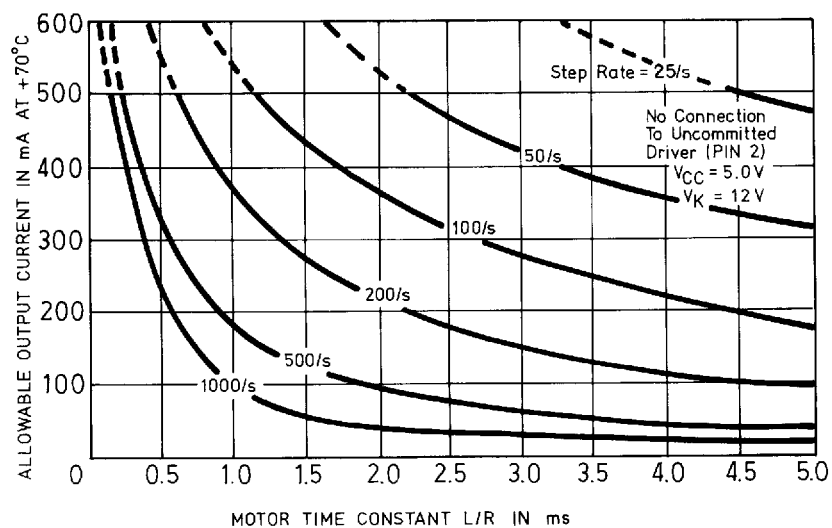
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UCN-4202A AND UCN-4203A
STEPPER-MOTOR TRANSLATORS AND DRIVERS

RECOMMENDED OPERATING CONDITIONS

| Characteristic | UCN-4202A | | | UCN-4203A | | | Units |
|--------------------------------|-----------|------|------|-----------|------|------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Supply Voltage, V_{CC} | 4.5 | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | V |
| V_K | — | 12 | 13.5 | — | 30 | 35 | V |
| Output Voltage, V_{CE} | — | — | 13.5 | — | — | 35 | V |
| Output Sink Current, I_{OUT} | — | — | 500 | — | — | 500 | mA |
| Operating Temperature, T_A | 0 | 25 | 70 | 0 | 25 | 70 | °C |

**MAXIMUM COLLECTOR CURRENT
AS A FUNCTION OF MOTOR TIME CONSTANT**



DWG. NO. A-11,185

- Notes: 1. Values shown take into account static d-c losses ($V_{SAT}I_{OUT}$ and $V_{CC}I_{CC}$) as well as switching losses induced by inductive flyback through the clamp diodes at $V_K = 12V$. Maximum package power dissipation is assumed to be 1.33 W at +70°C. Higher package power dissipation may be obtained at lower operating temperatures.
2. Use of external discrete flyback diodes will eliminate power dissipation resulting from switching losses and will allow the full 500 mA output capability (Output A, B, C, or D and the Driver Output) under all conditions.

UCN-4202A AND UCN-4203A
STEPPER-MOTOR TRANSLATORS AND DRIVERS

ELECTRICAL CHARACTERISTICS at $T_A = +25^\circ\text{C}$, $V_{CC} = +5.0\text{ V}$ (unless otherwise noted)

| Characteristic | Symbol | Applicable Devices | Test Conditions | Limits | | |
|----------------|----------|--------------------|-----------------|--------|------|-------|
| | | | | Min. | Max. | Units |
| Supply Current | I_{CC} | All | 2 Drivers ON | — | 85 | mA |

TTL Inputs (Pins 1, 9, and 15), TTL Outputs (Pins 13 and 14)

| | | | | | | |
|---------------------|---------------|-----------|---|-----|------|---------------|
| Input Voltage | $V_{IN(1)}$ | All | $V_{CC} = 4.5\text{ V}$ | 2.0 | — | V |
| | $V_{IN(0)}$ | All | $V_{CC} = 5.5\text{ V}$ | — | 0.8 | V |
| Input Current | $I_{IN(1)}$ | All | $V_{CC} = 5.5\text{ V}$, $V_{IN} = 2.4\text{ V}$ | — | 40 | μA |
| | $I_{IN(0)}$ | All | $V_{CC} = 5.5\text{ V}$, $V_{IN} = 0.4\text{ V}$ | — | -1.6 | mA |
| Input Clamp Voltage | V_{IK} | All | $I_{IN} = -12\text{ mA}$ | — | -1.5 | V |
| Output Voltage | $V_{OUT(1)}$ | All | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 80\text{ }\mu\text{A}$ | 2.4 | — | V |
| | $V_{OUT(0)}$ | UCN-4202A | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 3.2\text{ mA}$ | — | 0.4 | V |
| | | UCN-4203A | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 1.5\text{ mA}$ | — | 0.4 | V |
| Output Current | $I_{OUT(SC)}$ | All | $V_{CC} = 5.5\text{ V}$, $V_{OUT} = 0$ | — | 38 | mA |

Second-Step Monostable RC Input (Pin 11)

| | | | | | | |
|---------------|----------|-----|---|------|-----|---------------|
| Time Constant | t_{RC} | All | | 0.95 | 1.3 | s/RC |
| Reset Voltage | V_{MR} | All | $R = 200\text{ k}\Omega$, $I_{IN} = 25\text{ }\mu\text{A}$ | — | 50 | mV |
| Reset Current | I_{MR} | All | $V_{IN} = 2.0\text{ V}$ | 40 | — | μA |

Schmitt Trigger Inputs (Pins 10 and 12)

| | | | | | | |
|---------------------|--------------|-----|--|-----|------|---------------|
| Threshold Voltage | V_{T+} | All | | 1.3 | 2.1 | V |
| | V_{T-} | All | | 0.6 | 1.1 | V |
| Hysteresis | ΔV_T | All | | 0.2 | — | V |
| Input Current | $I_{IN(1)}$ | All | $V_{CC} = 4.5\text{ V}$, $V_{IN} = 2.4\text{ V}$, $T_A = 25^\circ\text{C}$ | — | 5.0 | μA |
| | | All | $V_{CC} = 4.5\text{ V}$, $V_{IN} = 2.4\text{ V}$, $T_A = 70^\circ\text{C}$ | — | 40 | μA |
| | $I_{IN(0)}$ | All | $V_{CC} = 5.5\text{ V}$, $V_{IN} = 0.4\text{ V}$ | — | -1.6 | mA |
| Input Clamp Voltage | V_{IK} | All | $I_{IN} = -12\text{ mA}$ | — | -1.5 | V |

Open Collector Outputs (Pins 2, 3, 4, 5, and 6)

| | | | | | | |
|-----------------------------|---------------|-----------|--|----|------|---------------|
| Output Leakage Current | I_{CEX} | UCN-4202A | $V_{CC} = 5.5\text{ V}$, $K = \text{Open}$, $V_{OUT} = 20\text{ V}$ | — | 500 | μA |
| | | UCN-4203A | $V_{CC} = 5.5\text{ V}$, $K = \text{Open}$, $V_{OUT} = 50\text{ V}$ | — | 500 | μA |
| Output Saturation Voltage | $V_{CE(SAT)}$ | UCN-4202A | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 300\text{ mA}$ | — | 500 | mV |
| | | | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 400\text{ mA}$ | — | 750 | mV |
| | | | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 500\text{ mA}$ | — | 900 | mV |
| | | UCN-4203A | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 300\text{ mA}$ | — | 850 | mV |
| | | | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 400\text{ mA}$ | — | 1100 | mV |
| | | | $V_{CC} = 4.5\text{ V}$, $I_{OUT} = 500\text{ mA}$ | — | 1350 | mV |
| Output Sustaining Voltage | $V_{CE(SUS)}$ | UCN-4202A | $I_{OUT} = 30\text{ mA}$, $t_p \leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$ | 15 | — | V |
| | | UCN-4203A | $I_{OUT} = 30\text{ mA}$, $t_p \leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$ | 35 | — | V |
| Turn-On Delay | t_{pd0} | All | $0.5\text{ }E_{in}$ (Pin 10) to $0.5\text{ }E_{out}$ | — | 10 | μs |
| Turn-Off Delay | t_{pd1} | All | $0.5\text{ }E_{in}$ (Pin 10) to $0.5\text{ }E_{out}$ | — | 10 | μs |
| Clamp Diode Leakage Current | I_R | UCN-4202A | $V_R = 20\text{ V}$ | — | 50 | μA |
| | | UCN-4203A | $V_R = 50\text{ V}$ | — | 50 | μA |
| Clamp Diode Forward Voltage | V_F | All | $I_F = 500\text{ mA}$ | — | 3.0 | V |

FUNCTIONAL DESCRIPTION

Power-On Reset

An internal RS flip-flop sets the Output A "ON" with the initial application of power. This state occurs approximately $30\ \mu\text{s}$ after the logic supply voltage reaches 4 V with supply rise times of up to $10\ \text{ms/V}$. Once reset, the circuit functions according to the logic input conditions.

Step Enable

Pin 9 (STEP ENABLE) must be held high to enable the step pulses for advancing the motor to reach the translator logic clock circuits. Pulling this pin low inhibits the translator logic.

Step Input

Pin 10 (STEP INPUT) is normally high. The logic will advance one position on the positive transition after the input has been pulled low for at least $1\ \mu\text{s}$. The STEP INPUT current specification is compatible with NMOS and CMOS.

Direction Control

The direction of output rotation is determined by the logic level at pin 12. If the input is held high the rotation is A-D-C-B; if pulled low the rotation is A-B-C-D. This input is also NMOS and CMOS compatible.

Output Enable

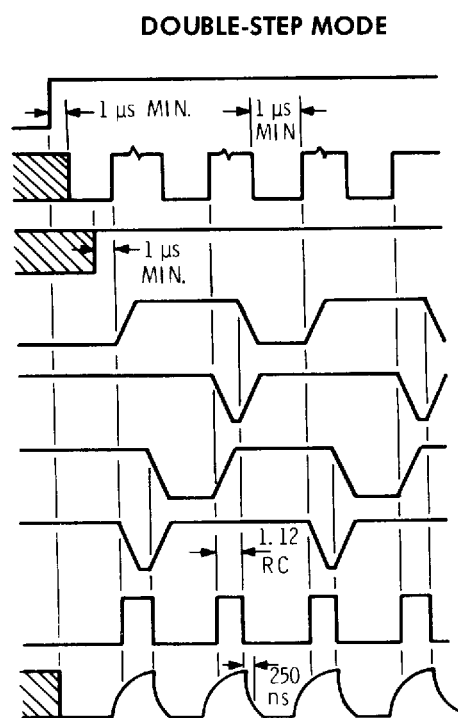
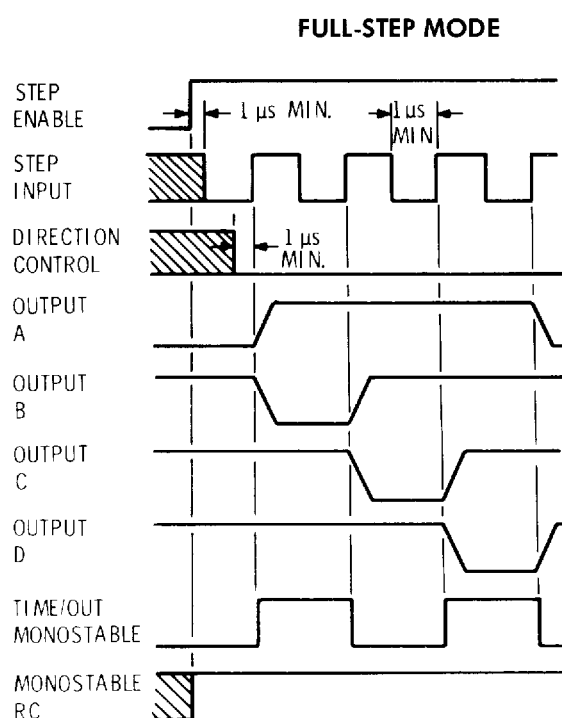
Outputs A through D are inhibited (all outputs OFF) when pin 1 (OUTPUT ENABLE) is at high level. This condition creates a potential for wired-OR device outputs, or other potential control functions such as chopping or bi-level drive.

Transient Suppression

All five power outputs are diode protected against inductive transients. Zener diode or resistor "flyback" transient suppression is often used, provided the peak output voltage does not exceed the sustaining voltage rating of the device (15 V for Type UCN-4202A or 35 V for Type UCN-4203A).

Full-Step/Double-Step

Full-step operation is the most commonly used drive technique. The devices are capable of unipolar drive without external active devices, either in a full-step mode (pin 11, Monostable RC, tied high), or in a double-step mode (pin 11 connected to RC timing). The double-step mode provides improved torque characteristics, while the specified angular increment is doubled.



Dwg. No. A-11,844

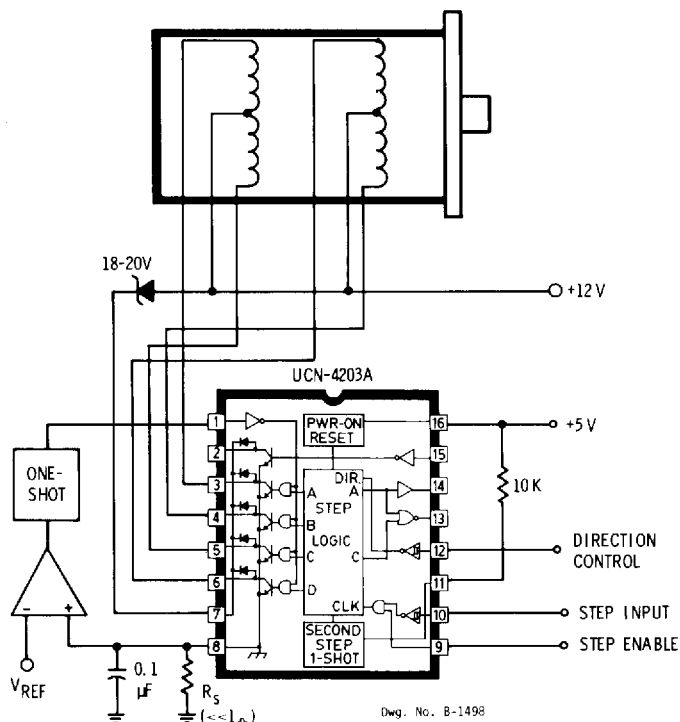
STEPPER MOTORS (Representative List)

| Manufacturer | Model | L/R | Typ. Ratings | Step |
|-------------------------|-------------|---------|--------------|------|
| Eastern Air Devices | LA23ACK-2 | 1.4 ms | 440 mA, 12 V | 1.8° |
| | LA23ACK-3 | 1.25 ms | 220 mA, 24 V | 1.8° |
| | LA23ACY-1 | 1.2 ms | 440 mA, 12 V | 7.5° |
| | LA34ADK-6 | 2.6 ms | 530 mA, 14 V | 1.8° |
| IMC Hanson | S-114 | 1.6 ms | 340 mA, 12 V | 7.5° |
| | S-115 | 1.9 ms | 130 mA, 12 V | 7.5° |
| | S-382 | 1.6 ms | 171 mA, 24 V | 7.5° |
| | S-406 | 4.3 ms | 280 mA, 24 V | 15° |
| | S-451 | 3.9 ms | 280 mA, 24 V | 7.5° |
| North American Phillips | K82701-P2 | 1.5 ms | 330 mA, 12 V | 7.5° |
| | K83701-P2 | 1.5 ms | 330 mA, 12 V | 15° |
| Septor | S-0912A | 1.5 ms | 340 mA, 12 V | 9° |
| Superior Electric | M061-FD-301 | 0.8 ms | 440 mA, 12 V | 1.8° |
| | M061-FD-311 | 1.5 ms | 220 mA, 20 V | 1.8° |

TYPICAL APPLICATIONS

CHOPPER DRIVE CIRCUIT

Used to Drive a 12 V, 500 mA
Unipolar Stepper Motor



DISC DRIVE APPLICATIONS

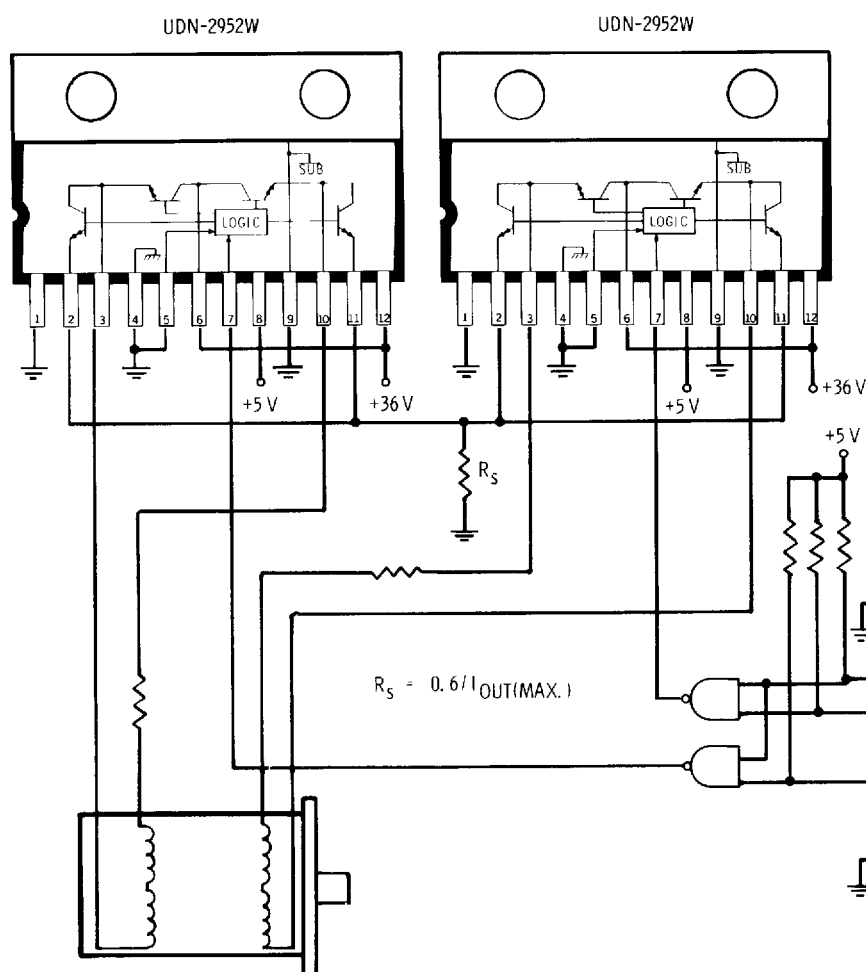
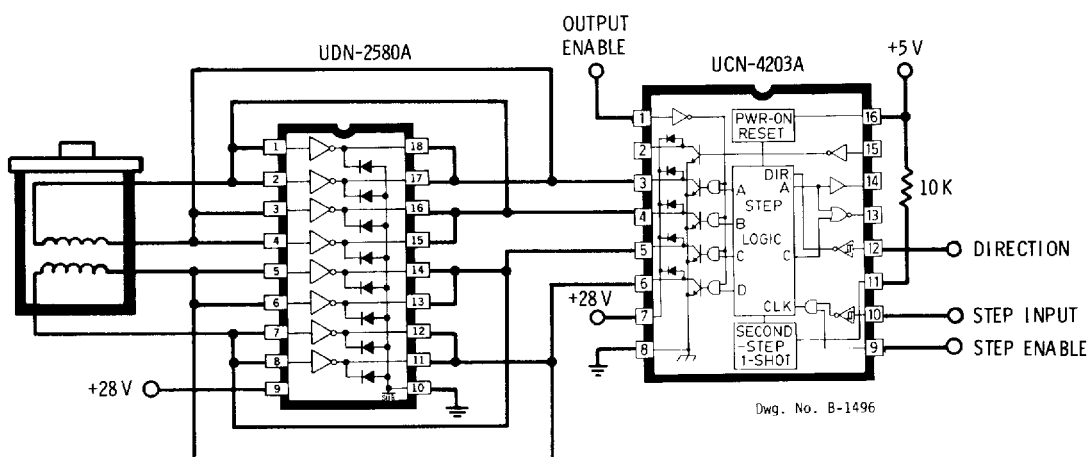
These stepper-motor translator/drivers provide additional special-purpose logic for use in disc drive applications. Pin 14 (STATE A) is high with OUTPUT A activated and is used with other drive logic in determining Track 0 Position on the disc. Pin 13 (TIME/OUT MONOSTABLE) in disc drive applications is called ON TRACK and is low with either OUTPUT A or OUTPUT C activated. It is used as a WRITE ENABLE condition with other drive logic.

An independent driver (pins 2 and 15) is used to control the head load solenoid.

TYPICAL APPLICATIONS (Continued)

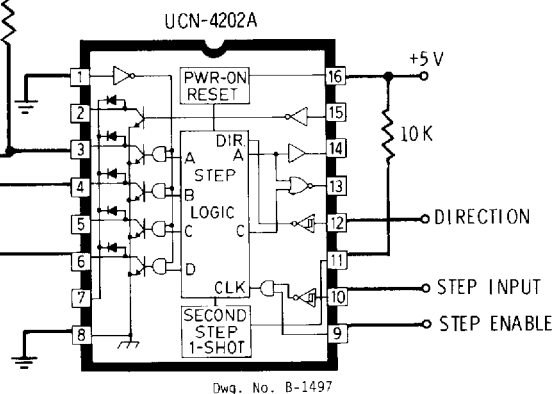
TWO-PHASE BIPOLAR DRIVE CIRCUIT

Used to Drive a 500 mA Stepper Motor
(UDN-2580A is described in Engineering Bulletin 29316)



TWO-PHASE BIPOLAR DRIVE CIRCUIT

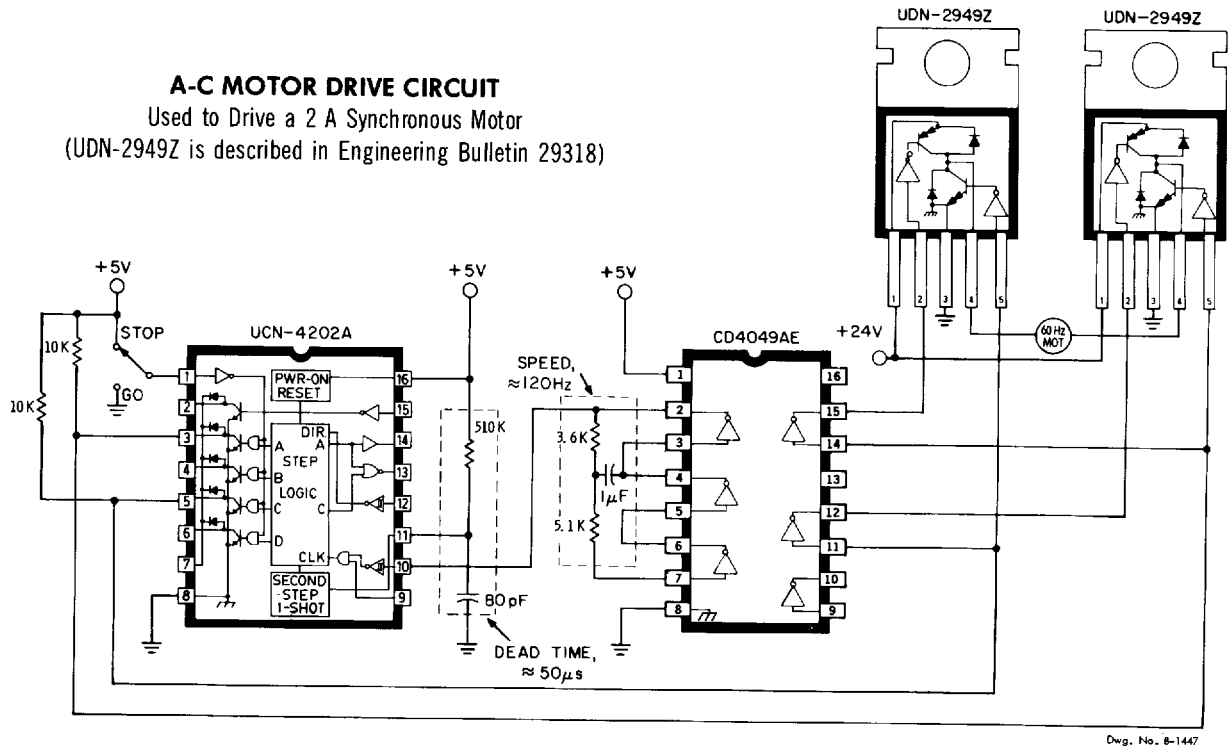
Used to Drive a 2A Stepper Motor
(UDN-2952W is described in
Engineering Bulletin 29319)



TYPICAL APPLICATIONS (Continued)

A-C MOTOR DRIVE CIRCUIT

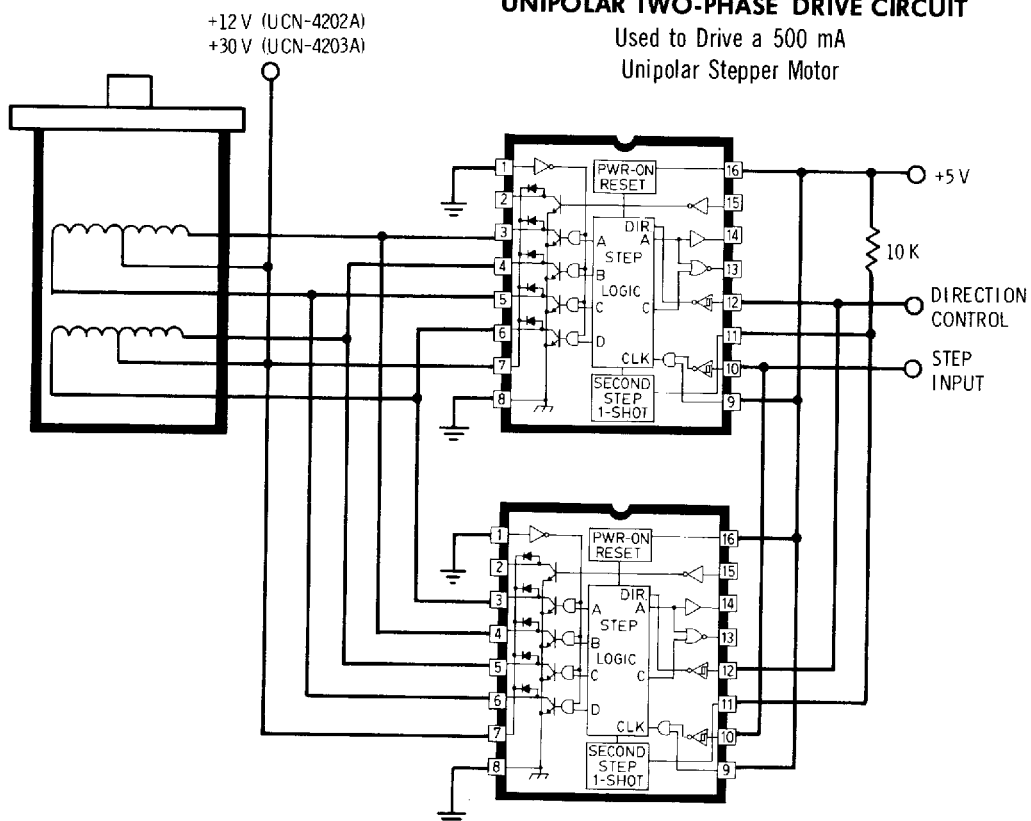
Used to Drive a 2 A Synchronous Motor
(UDN-2949Z is described in Engineering Bulletin 29318)



Dwg. No. B-1447

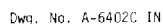
UNIPOLAR TWO-PHASE DRIVE CIRCUIT

Used to Drive a 500 mA
Unipolar Stepper Motor

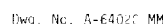


Dwg. No. B-1499

REFERENCES



Based on $1'' = 25.4 \text{ mm}$



from its use.

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