Motor Control

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Howard University

EECE691: Embedded Computing
Motors and Control Methods

- **DC Motor Control**
  - Forward, Reverse, Stop
  - Control by Manual Switch
  - Control by Relay
  - Control by Transistor
  - Control by H-Bridge
  - Control by Motor Driver

- **DC Stepper Motor Control**
  - Bipolar Stepper Motor
    - Control Driver
  - Unipolar Stepper Motor
    - Control Driver
DC Motors and Manual Control

A pair of SPDT switches controls on/off and direction; brakes to a stop.
DC Motors and Manual Control

Diagram D: SPST switches control on/off; SPDT sets direction

Diagram E: Two SPST switches (half bridge) control on/off & direction

Graph: Torque vs. RPM, showing that \( V_2 > V_1 \) at higher RPM values.
Selector Switch

- **SPST**: Single pole single throw.
- **SPDT**: Single pole double throw.
- **DPST**: Double pole single throw.
- **DPDT**: Double pole double throw.
- **DP3T**: Double pole three throw.
- **DP4T**: Double pole four throw.
- **3PDT**: Three pole double throw.
- **3P3T**: Three pole three throw.
## Selector Switch Diagram

<table>
<thead>
<tr>
<th>Form A - SPST-NO</th>
<th>Form X - SPST-DB-NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pole - Single Throw Normally Open</td>
<td>Single Pole - Single Throw Double Break - Normally Open</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form AA - DPST-NO</th>
<th>Form XX - DPST-DB-NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Pole - Single Throw Normally Open</td>
<td>Double Pole - Single Throw Double Break - Normally Open</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form B - SPST-NC</th>
<th>Form Y - SPST-DB-NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form BB - DPST-NC</td>
<td>Form YY - DPST-DB-NC</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Double Pole - Single Throw Normally Closed</td>
<td>Double Pole - Single Throw Double Break - Normally Closed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form C - SPDT</th>
<th>Form Z - SPDT-DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pole - Double Throw</td>
<td>Single Pole - Double Throw Double Break</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form CC - DPDT</th>
<th>Form ZZ - DPDT-DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Pole - Double Throw</td>
<td>Double Pole - Double Throw Double Break</td>
</tr>
</tbody>
</table>
DC Motor Control by Relay

[Diagram showing relay control circuit]

- Power supply or battery
- Double pole double throw changeover switch
- DC MOTOR

[Diagram of relay circuit with SW1, CL1, and connections to DC motor]

- SW1: Switch
- CL1: Control circuit
- To motor DC supply
Motor Control using a Relay

4 POLES—1 to 2 A

Motor Voltage

V+
GND

DPDT Relay

DPDT Relay

M

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Stop</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Stop</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Forward</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>Reverse</td>
</tr>
</tbody>
</table>

*NOTE: Action Y first, then apply X*
DC Motor Control using High Current Relay

Connector Details:

<table>
<thead>
<tr>
<th>W</th>
<th>R</th>
<th>B</th>
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</thead>
<tbody>
<tr>
<td>GND</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>GND</td>
<td>+5V</td>
<td>+12V</td>
</tr>
<tr>
<td>+5V</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>+5V</td>
<td>+5V</td>
<td>+12V</td>
</tr>
</tbody>
</table>

Lamp Color:
- Orange
- Green
- Red
- Off

*NOTE: Avoid this combination*
DC Motor Control with Transistor

TIP41 Series (TIP41/41A/41B/41C)
Medium Power Linear Switching Applications

The boxed part is an opto-isolator, Jameco Part #41030.

Motor Voltage

(+5V) → Port Pin
470 → 4.7K → B

GND

TIP122

B - C - E
Transistors for Control

A small current flowing this way...

...causes a much larger current (10x or more) to flow this way...

LOAD

NPN

LOAD

PNP

LOAD
Transistor vs. MOSFET

Transistor H-bridge

MOSFET H-bridge
Darlington (Transistor)

- Connection of two bipolar transistors in tandem in a single device.
- High gain (or beta)
- Less space
- Invented by Bell Laboratories engineer Sidney Darlington.
Transistor Array

MC1413, MC1413B, NCV1413B
High Voltage, High Current Darlington Transistor Arrays

ON Semiconductor®

PDIP-16
P SUFFIX
CASE 648

Pin 9

2.7k

5.0k

3.0k
Darlington Array

FEATURES

- TTL, DTL, PMOS, or CMOS- Compatible Inputs
- Output Current to 500 mA
- Output Voltage to 95 V
- Transient Protected Outputs

HIGH-VOLTAGE, HIGH-CURRENT DARLINGTON ARRAYS

Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads

UNIPOLAR STEPPER CONTROL

TYPICAL APPLICATIONS
Darlington with DPDT relays
MOSFET for Motor Control

Microchip TC4423/TC4424/TC4425
3A Dual High-Speed Power MOSFET Drivers

Power
- Logic high (max)
- PWM in (1%-99%)
- Logic low (off)

Direction
- Logic low (forward)
- Logic high (reverse)

R1 10 kΩ (BnBkOe)
R2 10 kΩ (BnBkOe)

+5 VDC

C1 1.0 μF (105)
C2 0.1 μF (104)

+9.6 VDC to +18 VDC

D1
D2 Schottky small-signal diodes

M1 Motor

IC1 3-amp Dual High-Speed MOSFET Driver

Diagram showing the connection of MOSFET to motor control circuit.
DC Motor H-Bridge Control

Diode  1N4002
Transistor  TIP41 NPN Power Transistor
Resistor  2.2 K  0.25 W
Rotation Control using H-Bridge

H-bridge CW rotation

H-bridge CCW rotation
Standard H-Bridge Control

A

B

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>stop</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>forward</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>reverse</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>PROHIBITED</td>
</tr>
</tbody>
</table>
Full/Half H-Bridge

A B
0 0 stop
0 1 forward
1 0 reverse
1 1 stop

A B
0 0 forward
0 1 PROHIBITED
1 0 stop
1 1 reverse
Bridge Motor Driver

Allegro MicroSystems, Inc. 2916

DUAL FULL-BRIDGE PWM MOTOR DRIVER

a bipolar stepper motor or bidirectionally control two dc motors.
Bridge Driver

L298
DUAL FULL-BRIDGE DRIVER

ORDERING NUMBERS: L298N (Multiwatt Vert.)
L298HN (Multiwatt Horiz.)
L298P (PowerSO20)
H-Bridge Driver

LMD18200
3A, 55V H-Bridge

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

Texas Instruments
SN754410
QUADRUPLE HALF-H DRIVER

- 1-A Output-Current Capability Per Driver
- Applications Include Half-H and Full-H Solenoid Drivers and Motor Drivers
- Designed for Positive-Supply Applications
- Wide Supply-Voltage Range of 4.5 V to 36 V
DC Motor Driver

FAN8082 Bi-directional DC Motor Driver

Parameter | Symbol | Operating voltage range
--- | --- | ---
Operating supply voltage | $SV_{CC}, PV_{CC}$ | 7 – 18

**LOGIC INPUT & OUTPUT TABLE**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin #4</td>
<td>Pin #5</td>
<td>Pin #2</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>*Low</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>*Low</td>
</tr>
</tbody>
</table>
Stepper Motors

STEPPER MOTORS

2-phase
Unipolar (Single Polarity)

2-Phase
Bipolar
Stepper Motors

Bipolar Mode
250 mA @ 5 Vdc

<table>
<thead>
<tr>
<th>CW</th>
<th>CCW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
</tr>
</tbody>
</table>
Stepper Motor Structure

Rotor Shaft

Rotor (permanent Magnet)

Stator (Coils wound)

Teeth are half-step out-of-phase Alignment

Rotor

Stator

Off

Stator

On

Rotor

3.6°
Stepper Motor - Theory

- Magnetic Field Created by Energized Coil
- Steps for “One phase On” for two phase stepping motor
Stepper Motor Theory

• “Two Phase On” for a 2-phase stepper
Half-Stepping
Stepper Motor – Speed vs. Torque

- Holding torque
- Maximum starting torque
- Pull-out torque
- Pull-in range
- Unstartable range
- Unrotatable range
- Maximum starting frequency
- Maximum slewing frequency
- Stepping rate (Hz)
Sequence for Unipolar and Bipolar

**BIPOLAR**

<table>
<thead>
<tr>
<th>Step</th>
<th>$Q_1-Q_4$</th>
<th>$Q_2-Q_3$</th>
<th>$Q_3-Q_6$</th>
<th>$Q_6-Q_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

**UNIPOLAR**

**Normal 4-Step Sequence**

<table>
<thead>
<tr>
<th>Step</th>
<th>$Q_1$</th>
<th>$Q_2$</th>
<th>$Q_3$</th>
<th>$Q_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
### Bipolar Stepper Control Sequence

<table>
<thead>
<tr>
<th>Bipolar Step</th>
<th>Q2-Q3</th>
<th>Q1-Q4</th>
<th>Q6-Q7</th>
<th>Q5-Q8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
Unipolar Stepper Motor Sequence

<table>
<thead>
<tr>
<th>Unipolar Step</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
**Bipolar Stepper Motor Driver**

**MC3479 Stepper Motor Driver**

- Two-phase stepper motor in the bipolar mode.
- Single Supply Operation: 7.2 to 16.5 V
- 350 mA/Coil Drive Capability

**Table of Step Sequences**:

<table>
<thead>
<tr>
<th>Step</th>
<th>A</th>
<th>B</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Bipolar Driver

Part Number | Package
------------|----------
UDN2916B   | 24-Pin DIP
UDN2916EB  | 44-Lead PLCC
UDN2916LB  | 24-Lead SOIC

FEATURES
- 750 mA Continuous Output Current
- 45 V Output Sustaining Voltage

DUAL FULL-BRIDGE PWM MOTOR DRIVER
For BIPOLAR STEPPER/DC

UDN2916B (DIP)

LOAD SUPPLY
E
SENSE
OUT
GROUND
PHASE
VREF
RC
LOGIC SUPPLY
Unipolar Driver

Unipolar Stepper-Motor Driver

5804

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

Typical Application:
L/R Stepper-Motor Drive
Unipolar Stepper Driver

SLA7024M, SLA7026M, AND SMA7029M

HIGH-CURRENT PWM, UNIPOLAR STEPPER MOTOR CONTROLLER/DRIVERS

TYPICAL STEPPER MOTOR APPLICATIONS
(Half of Each Device Shown)
SLA7024M and SLA7026M

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

<table>
<thead>
<tr>
<th>Sequence</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input A</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Input A'</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Input B</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Input B'</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Outputs ON</td>
<td>AB</td>
<td>A' B</td>
<td>AB</td>
<td>A' B</td>
<td>AB</td>
</tr>
</tbody>
</table>
## Motors

### 12VDC Bipolar Stepper Motor
- 3.6°/Step
- No. of phases: 2
- Detent torque: 80 g-cm
- Holding torque: 600 g-cm
- Phase resistance: 35Ω
- Phase inductance: 35mH
- Current: 480mA
- Mounting hole size: 0.11"
- Shaft size: 0.43" x 0.167" Dia.
- Motor size: 1.60" Dia. x 1.29" H

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Mfr. Cross Ref. No.</th>
<th>1</th>
<th>10</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>105081</td>
<td>2M4200</td>
<td>$6.99</td>
<td>$6.59</td>
<td>$4.95</td>
</tr>
</tbody>
</table>

### 12VDC Unipolar Stepper Motor
- 3.6°/Step
- No. of phases: 4
- Detent torque: 80 g-cm
- Holding torque: 600 g-cm
- Phase resistance: 75Ω
- Phase inductance: 35mH
- Current: 150mA
- Mounting hole size: 0.11"
- Shaft size: 0.43" x 0.167" Dia.
- Motor size: 1.60" Dia. x 1.29" H

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Mfr. Cross Ref. No.</th>
<th>1</th>
<th>10</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>105680</td>
<td>2M420D</td>
<td>$8.90</td>
<td>$8.79</td>
<td>$6.99</td>
</tr>
</tbody>
</table>

### 12VDC Unipolar Stepper Motor
- .08°/Step
- No. of phases: 4
- Detent torque: 400 g-cm
- Holding torque: 400 g-cm
- Phase resistance: 200Ω
- Phase inductance: 49.5mH
- Current: 66mA
- Mounting hole size: 0.14"
- Shaft size: 0.38" x 0.194" Dia.
- Motor size: 1.16" Dia. x 0.98" H

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Mfr. Cross Ref. No.</th>
<th>1</th>
<th>10</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>173110</td>
<td>305VJD2AH</td>
<td>$11.49</td>
<td>$10.35</td>
<td>$9.35</td>
</tr>
</tbody>
</table>

### Bipolar and Unipolar Stepper Motors

![Bipolar Stepper Motor](image1)

![Unipolar Stepper Motor](image2)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Mfr. Cross Ref. No.</th>
<th>Fig.</th>
<th>Step Angle</th>
<th>No. of Phases</th>
<th>Drive System (VDC)</th>
<th>Phase Resist (Ohms)</th>
<th>Phase Inductance (mH)</th>
<th>Detent Torque (g-cm)</th>
<th>Holding Torque (g-cm)</th>
<th>Mounting Hole (In.)</th>
<th>Shaft Dia (In.)</th>
<th>Shaft Length (In.)</th>
<th>Motor Height (In.)</th>
<th>Motor Width (In.)</th>
<th>Motor Depth (In.)</th>
<th>Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>117951</td>
<td>LBH2273-M1</td>
<td>1</td>
<td>7.5°</td>
<td>2</td>
<td>Bipolar</td>
<td>6</td>
<td>800</td>
<td>100</td>
<td>1000</td>
<td>2.50</td>
<td>1.00</td>
<td>1.25</td>
<td>1.00</td>
<td>3.75</td>
<td>2.50</td>
<td>$3.75</td>
</tr>
<tr>
<td>163395</td>
<td>5017-93S1</td>
<td>2</td>
<td>0.9°</td>
<td>2</td>
<td>Bipolar</td>
<td>84</td>
<td>30</td>
<td>280</td>
<td>25</td>
<td>791</td>
<td>1.73</td>
<td>0.15</td>
<td>1.84</td>
<td>1.20</td>
<td>4.95</td>
<td>3.75</td>
</tr>
<tr>
<td>163403</td>
<td>4017-90E1</td>
<td>2</td>
<td>1.8°</td>
<td>2</td>
<td>Bipolar</td>
<td>92</td>
<td>38</td>
<td>240</td>
<td>32</td>
<td>664</td>
<td>1.73</td>
<td>0.15</td>
<td>1.86</td>
<td>1.25</td>
<td>4.95</td>
<td>3.75</td>
</tr>
<tr>
<td>105681</td>
<td>2M420D</td>
<td>3</td>
<td>3.6°</td>
<td>2</td>
<td>Bipolar</td>
<td>12</td>
<td>25</td>
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Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8
**GBM Bipolar and Unipolar Stepper Motors**

- Bearing type: ball
- Dielectric strength: 500V, 50Hz/minute
- 18" lead wires
- Step angle: 1.8°
- Ambient temperature: -10°C to +55°C
- Insulation resistance: 100MΩ @ 500VDC
- Use P/N 161998, pg 162, for shaft coupler

---

### GBM Bipolar and Unipolar Stepper Motors Specifications

<table>
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<th>Product Number</th>
<th>Fig.</th>
<th>NEMA Form</th>
<th>No. of Phases</th>
<th>Drive System</th>
<th>Voltage (VDC)</th>
<th>Phase Resistance (Ohms)</th>
<th>Current (mA)</th>
<th>Phase Inductance (mH)</th>
<th>Detent Torque (g-cm)</th>
<th>Holding Torque (g-cm)</th>
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<th>Mounting Holes (in.)</th>
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<th>Shaft Length (in.)</th>
<th>Motor Diameter (in.)</th>
<th>Motor Height (in.)</th>
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![GBM is an ISO-9001 Certified Company](image_url)
Dual Motor Gearbox Kit

Two independent motors, gearboxes, and axles
Voltage = 3vdc
RPM = 81 or 282
Reduction = 203:1 or 58:1
Stall Torque = 124 or 36 oz-in (8.9 or 2.5 kg-cm)
Wheels = Sport (STS-01), Off Road (ORT-01), Truck (ORT-02)

Price [ $13.95 ]
Model Number [ DMG-01 ]
Weight [ 0.25 ]
Easy One-Touch slide switch with 3 selectable gear ratios.

Price: $14.40

http://www.gbsontech.com/menu_electronic_courses45.html

GO TO MENU
Selectable Gear Box

Mtn. # OYW-G825

Three gear ratios are possible: 8:1, 4.5:1, 3:1. With one touch of a slide switch, brakeless allows for flexibility in project applications. With our touch of a slide switch, drive pulleys, cars, wheels, or rings with high torque or speed. Adjustable mounting. A great science fair project item! If you need speed variations, then look no further.
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Other products in the geared DC Motors (Kit) category
Dual Motor Gearbox Kit

Sport Tire - 2.2" x 1.0" (pair)

- Diameter = 2.2"
- Width = 1.0"
- Motor = Dual Motor Gearbox (DMG-01)

Price: $7.95
Model Number: STS-01
Weight: 0.19
Motor with Wheels