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LS7263

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BRUSHLESS DC MOTOR SPEED CONTROLLER

FEATURES:

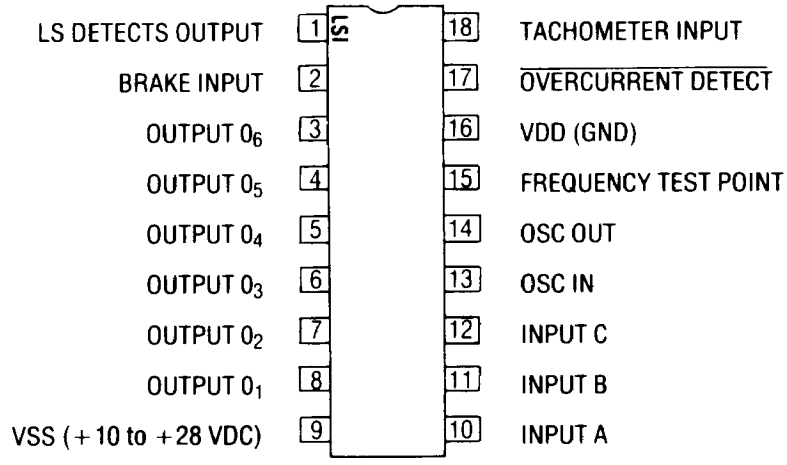
- Highly accurate speed regulation (±.1% derived from XTL controlled time base.)
- Rapid acceleration to speed with little overshoot
- **Static braking**
- 10V to 28V supply range
- Low speed detection output
- **Over current detection logic**
- Power on reset
- Six outputs drive power switching bridge directly
- 18 pin dual-in-line package

DESCRIPTION:

The LS7263 is a monolithic, ion implanted MOS circuit designed to control the speed of a 3-phase, brushless D.C. motor. This specific circuit is programmed for use in 3600 RPM applications. The circuit utilizes a 3.58 MHz crystal to provide its accurate speed regulation time base. Overcurrent circuitry is provided to protect the windings, associated drivers and power supply. A positive braking feature is provided to effect rapid deceleration.

Speed corrections are made by measuring the time between tachometer inputs and varying the on time of the drive signal applied to each winding. A sampling window is generated using tachometer input time intervals during which crystal derived clock pulses are accumulated. The contents of the accumulator provide the address of a look up table that has been derived from the physical characteristics of the motor and the load. The look up table output determines the amount of on time for each coil. Positive and negative signals are applied sequentially to each winding driver through the output decoder/driver section.

A static type positive braking system shorts all winding together upon receipt of the brake input. This system creates an electrical load on the motor thus causing rapid deceleration. An overcurrent condition, when sensed at the overcurrent detection input, disables all six winding outputs. Outputs will be reenabled upon removal of the overcurrent condition.



TOP VIEW
Fig. 1

* See page 4 for availabie configurations.

INPUT/OUTPUT DESCRIPTION:

LS DETECT OUTPUT (PIN 1).
This output provides a D.C. level which is high for speeds less than 1100 RPM. It may be used to determine activation of a Winchester drive head.

BRAKE INPUT (PIN 2).
A high level applied to this input turns off outputs 0_1-0_3 and turns on outputs 0_4-0_6, shorting the windings together. The brake input has priority over all other inputs. The brake input is provided with a pull-up resistor.

INPUT/OUTPUT DESCRIPTION: (continued)

OUTPUTS 0_6, 0_5, 0_4 (PINS 3-5).
These outputs provide the base current (through external limiting resistors) to NPN drivers of the motor coils. They are enabled in the sequence described in Table 1 and for a duration as determined by the internal speed regulation data.

OUTPUTS 0_3, 0_2, 0_1 (PINS 6-8).
The outputs provide the base current to the PNP drivers of the motor coils. They are enabled per Table 1 and the internal speed regulation data.

DESCRIPTION OF OUTPUT SIGNALS: (See Figures 2C, 3C)
An output pair turn on at a change of commutator input state and remain on for a period of time determined by the rotational speed measured within the latest sampling window. The output pulse can be zero if speed is too high. If other than zero, the output width follows the formula OPW (Clock Periods) = (192 +n x 384) x 4 ÷ number of poles, where n varies from zero to 14. If the look up table indicates n is greater than 14, the pair remain on until the next commutation change.

VSS (PIN 9).
Supply voltage positive terminal, (+10 to +28 Vdc.)

A, B, C INPUTS (PINS 10-12).
These inputs have pull up resistors and provide control of the output commutation sequence as per Table 1. A, B, C orginate at the position sensors of the motor (see fig. 2) and must sequence in cyclic order (only one input changes at any time). Figure C illustrates a method for controlling the motor direction of rotation. Figure D indicates how one external invertor may be used to use a 120° circuit type in a 60° sensor separation application (or 60° to 120°).

OSC IN (PIN 13), OSC OUT (PIN 14)
Pin 13 provides one of the two ports necessary for connecting a crystal. It may also be used to drive the circuit from an external clock. Pin 14 is used as the second connection when using a crystal for oscillation. Limited variable speed operation can be obtained by using the oscillator depicted in Figure A whose nominal frequency is 3.58 MHz.

FREQUENCY TEST POINT (PIN 15).
This test output provides the user with a point to measure the oscillator frequency without loading the oscillator. It provides a signal which is one sixth of the oscillator frequency.

VDD (PIN 16).
Supply voltage negative terminal (ground).

$\overline{\text{OVERCURRENT DETECT}}$ (PIN 17).
The Overcurrent Detection Input provides the user a way of protecting the motor windings, drivers and power supply from an overload condition. The user provides a fractional ohm resistor between the positive supply and the common emitters of the PNP drivers. This point is connected to a potentiometer (e.g. 100k ohm), the other end of which is connected to ground and the wiper connected to the overcurrent input. The wiper pickoff is adjusted so that the outputs 0_1-0_6 are off for currents greater than the limit. (Reference Fig. 5) An alternative overcurrent detection circuit is illustrated in Figure B. An overcurrent condition is sensed and latched causing the overcurrent input (pin 17) to become low. When the overcurrent condition terminates, the next positive edge of the chopping frequency will cause pin 17 to become high. This circuit limits the maximum output switching rate to the chopping frequency when an overcurrent condition occurs.

An example of setting up the over current follows:

1. Determine the fractional ohm resistance and the maximum current to determine the voltage drop across the resistor and call this V_{OC}.
2. Apply V_{SS}-V_{OC} to the fractional ohmage end of the potentiometer.
3. Hold A, B and C in a known state (e.g. 000). This will enable a pair of outputs in accordance with Table 1.
4. Adjust the potentiometer until outputs 0_1-0_3 are all at V_{SS} and 0_4-0_6 are at ground.
5. Remove the voltage from the potentiometer and connect the potentiometer to the transistor end of the fractional ohm resistor.

TACHOMETER INPUT (PIN 18).
The signal applied to the tachometer input originates at a motor position sensor (one of the commutation inputs may be used). Each negative edge of the tachometer input is synchronized by the one sixth oscillator frequency. The resulting signal 1) transfers new speed regulation data to the "on time" data storage latches, 2) resets the clock pulse accumulator and 3) originates a new sampling window. The tachometer input is provided with a pull-up resistor.

MAXIMUM RATINGS:

PARAMETER	SYMBOL	VALUE	UNITS
Storage Temperature	T_{stg}	−65 to +150	°C
Operating Temperature			
1. Plastic	T_{ap}	−25 to +70	°C
2. Ceramic	T_{ac}	−55 to +125	°C
Voltage (any pin to V_{SS})	V_{max}	−30 to+ 0.5	VOLTS

DC ELECTRICAL CHARACTERISTICS: (+10 to +28 VDC)

SUPPLY CURRENT	SYMBOL	MIN.	MAX.	UNITS
(Excluding Outputs)	I_{DD}	—	22	mA

INPUT SPECIFICATIONS:
Brake, commuting and tachometer (Pins 2, 10, 11, 12, 18)

INPUT VOLTAGE	MIN.	MAX.	UNITS
Logic "1"	V_{SS} - 2.5	V_{SS}	VOLTS
Logic "0"	0	V_{SS} - 5	VOLTS

INPUT CURRENT
Each of the five inputs provides an internal constant current source to V_{SS} of 200 to 400ua (typically 300ua)

$\overline{\text{OVERCURRENT DETECTION INPUT}}$ (PIN 17)

INPUT VOLTAGE	MIN.	MAX.	UNITS
Logic "1"	$(V_{SS} \div 2) + .25$	V_{SS}	VOLTS
Logic "0"	0	$(V_{SS} \div 2) - .25$	VOLTS

Theroretical switching point for the $\overline{\text{Overcurrent Detection Input}}$ is one half of the power supply. Manufacturing tolerances cause the switching point to vary plus or minus .25 volts. After manufacture, the switching point remains within 10mv over time and temperature. The input switching sensitivity is a maximum of 50mV. There is no hysteresis on the overcurrent detection input.

OSCILLATOR INPUT (PIN 13). (When driven from external source.)

	MIN.	MAX.	UNITS
Logic "1"	$V_{SS} - 1$	V_{SS}	VOLTS
Logic "0"	0	V_{SS}-6	VOLTS

OUTPUT SPECIFICATIONS

596 KHz TEST (PIN 15)
Designed for 10MΩ , 20pf scope probe.

LS DETECT OUTPUT (PIN 1)

	MIN.	MAX.	UNITS	CONDITIONS
I_{SOURCE}	1.0		mA	Output short circuit to V_{DD}
I_{SINK}	10.0		ua	Output at .5V

O_1-O_6 (PINS 3-8)
O_1-O_3 are current sinks
O_4-O_6 are current sources

Outputs turn on in pairs (see figs. 2C, 3C and 4). For example (see dotted line, fig. 4):
Q8 and Q4 are on, thus enabling a path from the positive supply through the fractional ohm resistor, emitter-base junction of Q101, Q8, Q4, R5 and the base emitter junction of Q105 to ground. The current in the above described pattern is determined by the power supply voltage, the value of R1, the voltage drops across the base-emitter, junction of Q101 and Q105 (1.4 volts for single transistor or 2.8V for Darlington pairs), the impedance of Q8 and Q4 and the value of R5.

TABLE 1A –01,

INPUTS A	B	C	OUTPUTS ENABLED	DRIVER A*	DRIVER B*	DRIVER C*
0	0	0	O_1, O_5	+	–	OFF
1	0	0	O_3, O_5	OFF	–	+
1	1	0	O_3, O_4	–	OFF	+
1	1	1	O_2, O_4	–	+	OFF
0	1	1	O_2, O_6	OFF	+	–
0	0	1	O_1, O_6	+	OFF	–

TABLE 1B –02, –03, –07

INPUTS A	B	C	OUTPUTS ENABLED	DRIVER A*	DRIVER B*	DRIVER C*
0	0	1	O_2, O_6	OFF	+	–
1	0	1	O_2, O_4	–	+	OFF
1	0	0	O_3, O_4	–	OFF	+
1	1	0	O_3, O_5	OFF	–	+
0	1	0	O_1, O_5	+	–	OFF
0	1	1	O_1, O_6	+	OFF	–

Push pull drivers are made up of pairs of Outputs: O_1 and O_4 (Driver A), O_2 and O_5 (Driver B), O_3 and O_6 (Driver C).

*See Fig. 4

DESCRIPTION OF AVAILABLE TYPES

TYPE	POLES	SENSOR SEPARATION	GAIN*
7263-01	4	60°	Medium
7263-02	8	120°	High
7263-03	4	120°	Medium
7263-07	8	120°	Medium

*Gain describes the change of output duty cycle as a function of change motor speed. For the high gain type, the duty cycle is caused to change from 0% to 100% over a 6 RPM motor speed change. For the medium gain type, the duty cycle changes from 0% to 100% when the motor speed changes by 40 RPM.

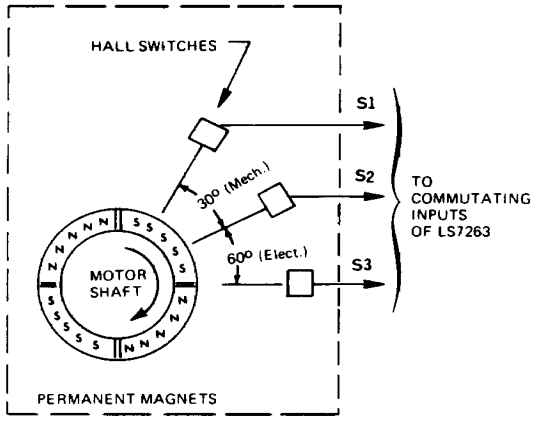
The following chart provides the recommended value for R5. R4 and R6 are the same value.

OUTPUT CURRENT
(DRIVING DARLINGTON PAIRS)

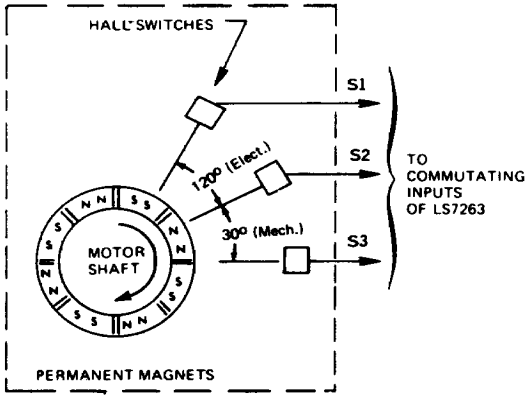
POWER SUPPLY VOLTS	20	15	10	7.5	5	2.5	mA
12	.1	.25	.56	.86	1.5	3.3	
15	.33	.51	.92	1.3	2.1	4.6	
18	*	.76	1.3	1.7	2.8	5.8	
21	*	*	1.6	2.2	3.3	7.0	
24	*	*	1.9	2.6	4.0	8.3	
28	*	*	*	3.2	4.9	9.9	

*causes excessive power dissipation.

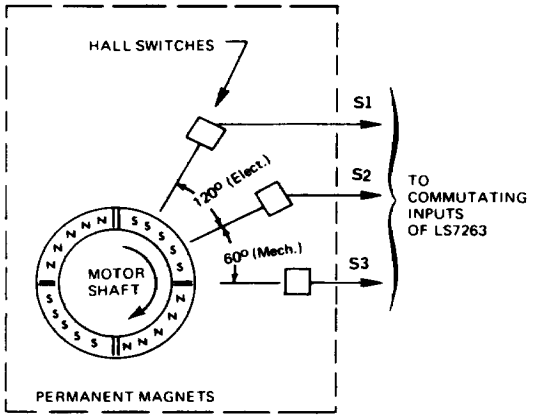
RESISTANCE IN KILOHMS



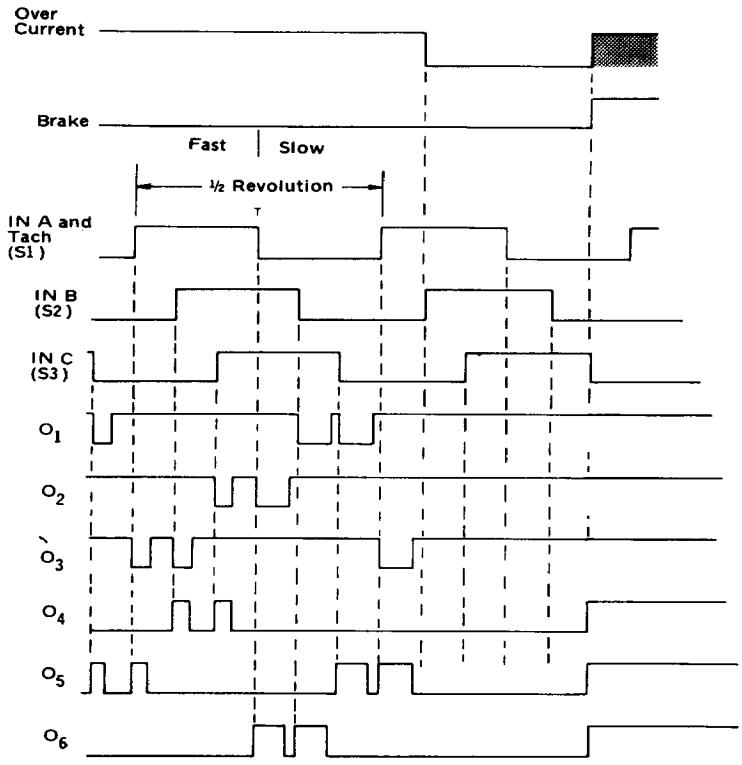
HALL SWITCH POSITIONING DIAGRAM FOR LS7263-01
FIGURE 1B



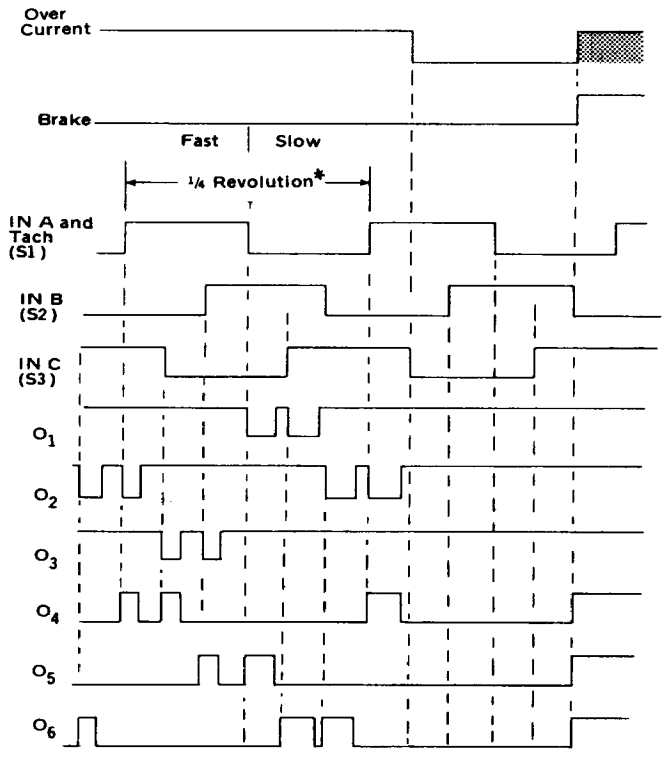
HALL SWITCH POSITIONING DIAGRAM FOR LS7263-02, 07
FIGURE 2B



HALL SWITCH POSITIONING DIAGRAM FOR LS 7263-03
FIGURE 3B

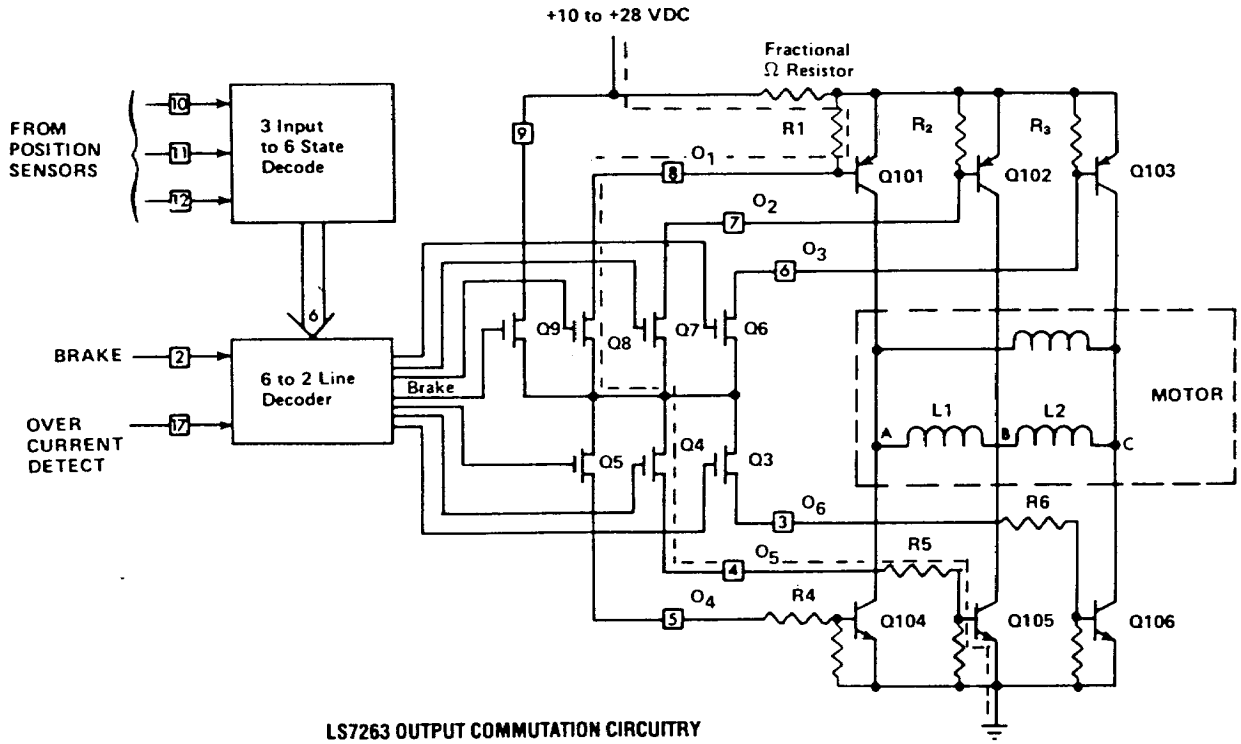


TIMING DIAGRAM FOR LS7263-01
FIGURE 2C

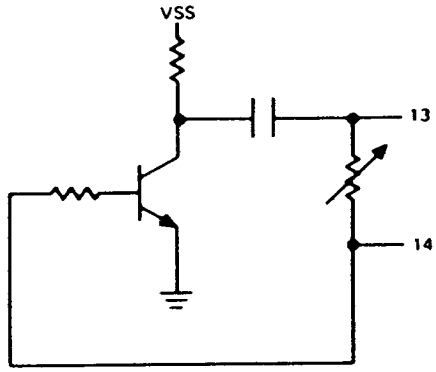


TIMING DIAGRAM FOR LS7263-02, 03, 07
FIGURE 3C

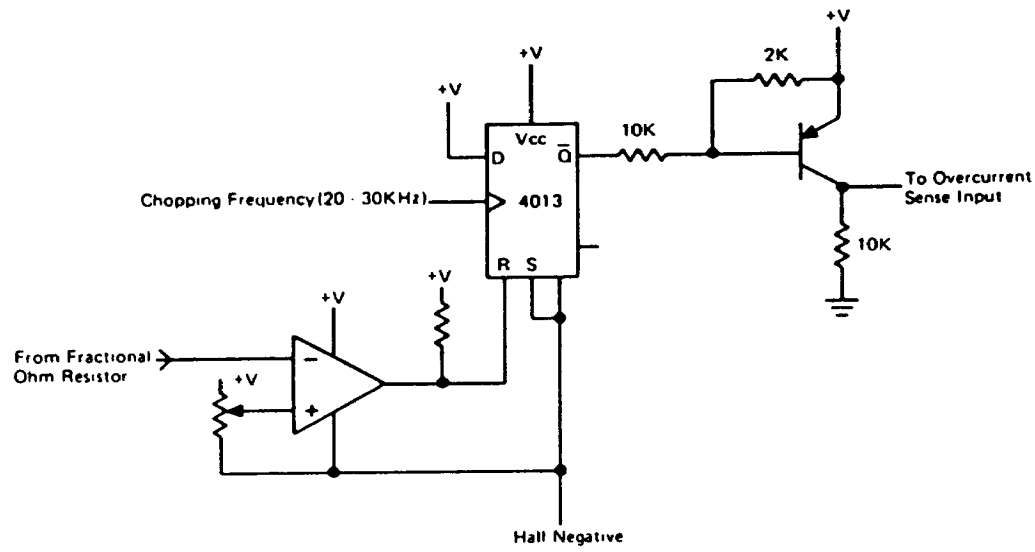
* ½ Revolution for LS 7263-03



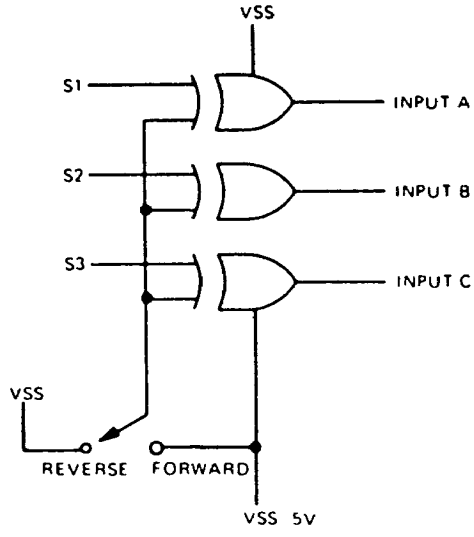
LS7263 OUTPUT COMMUTATION CIRCUITRY
Figure 4



VARIABLE OSCILLATOR · FIGURE A

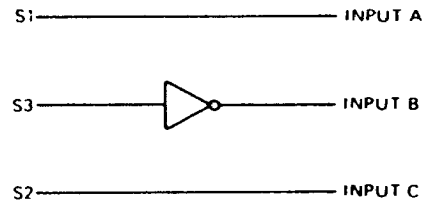


EXTERNAL OVERCURRENT SENSE WITH CHOPPING - FIGURE B

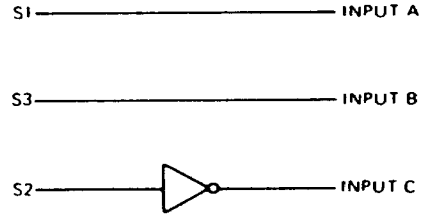


FORWARD REVERSE OPERATION FIGURE C

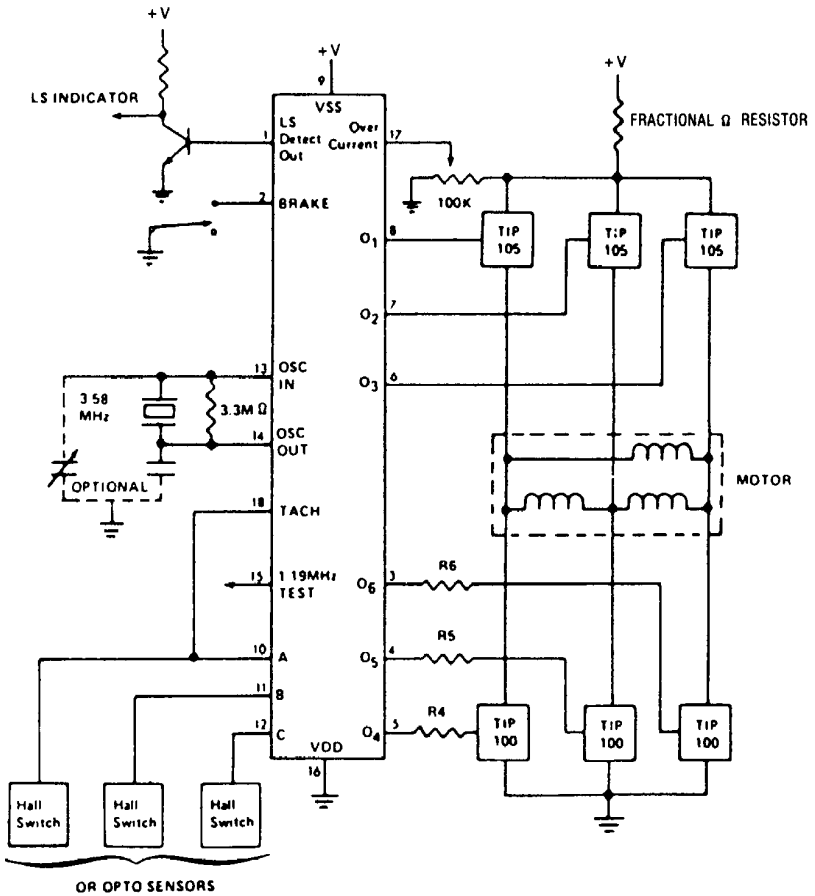
Translation from 120° electrical separation to 60° electrical separation



60° MOTOR TO 120° CHIP



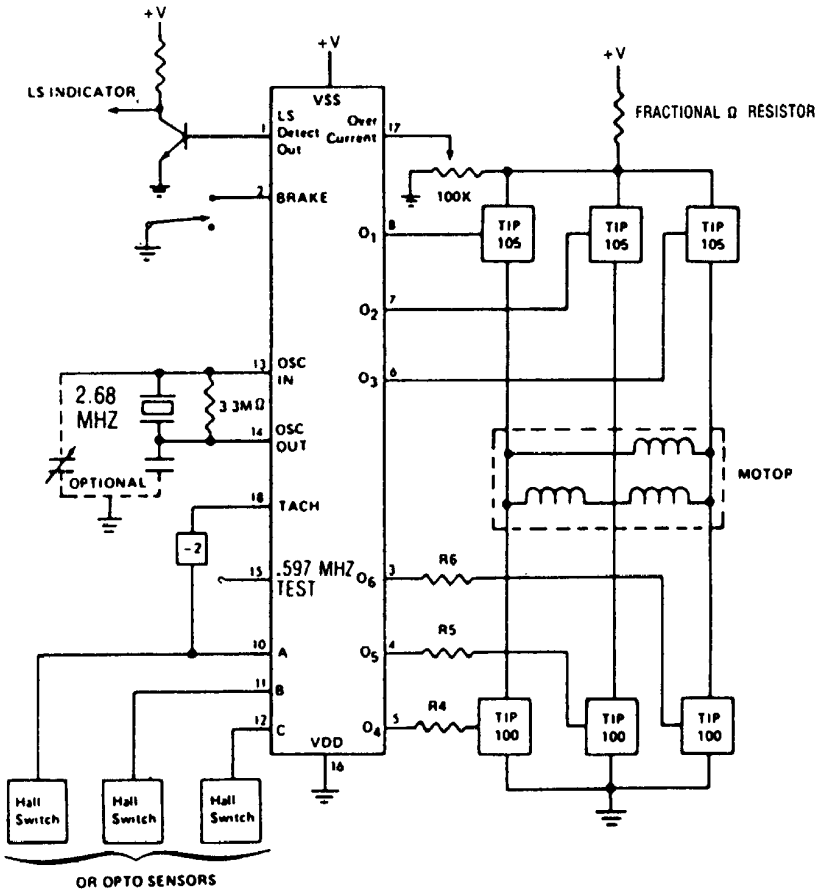
SENSOR SEPARATION CONVERSION FIGURE D



APPLICATION DIAGRAM

THREE PHASE BRUSHLESS DC MOTOR
OPERATING AT 3600 RPM

Figure 5

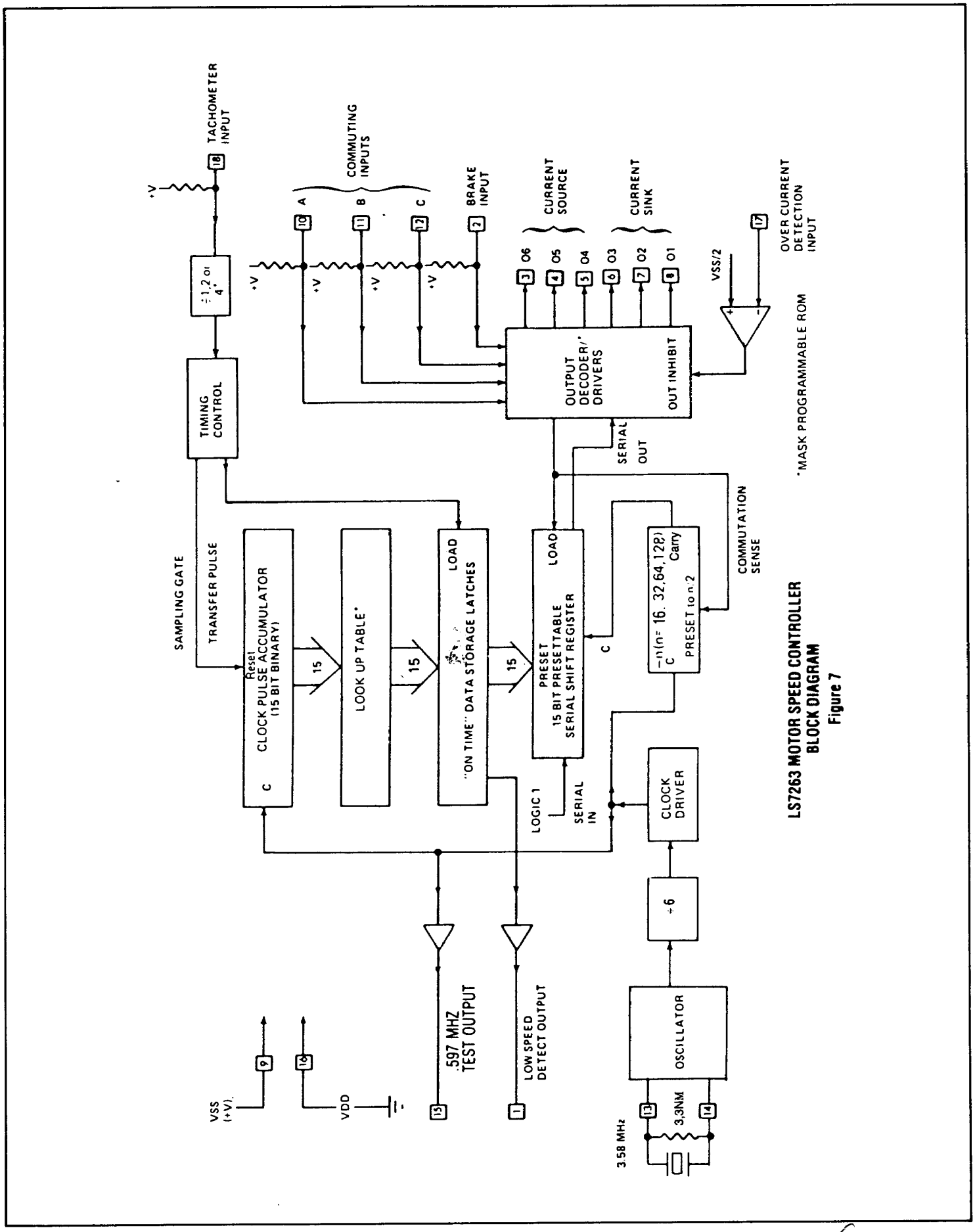


Tach input using ÷2 with output data rate doubled to achieve 5400 RPM operation.

APPLICATION DIAGRAM

THREE PHASE BRUSHLESS DC MOTOR
OPERATING AT 5400 RPM

Figure 6



LS7263 MOTOR SPEED CONTROLLER
BLOCK DIAGRAM
Figure 7