MOTOROLA

MC14460

CMOS LSI
(LOW-POWER COMPLEMENTARY MOS)

AUTOMOTIVE SPEED CONTROL PROCESSOR

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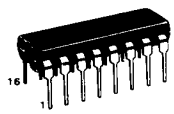
The MC14460 device is designed to measure vehicle speed and provide pulse-width modulated outputs to trim a throttle positioning servo to maintain an internally stored reference speed.

The stored reference speed can be altered by the DECEL and ACCEL driver commands. The DECEL command trims down the speed, while ACCEL trims up the speed.

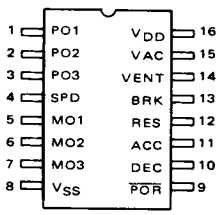
A BRAKE input is provided to turn off the outputs with a RESUME driver command to return the vehicle to the last stored speed.

- On-Chip Master Oscillator for System Time Reference
- Separate On-Chip Pulse Oscillator for Output Pulse Width Adjustment (Analogous to System Gain)
- Diode Protection on All Inputs
- Internal Redundant Brake and Minimum Speed Checks
- Acceleration Rates Controlled During ACCEL and RESUME Modes of Operation
- Low Frequency Speed Sensors Used
- No Throttle Position Feedback Required
- Power-On Reset
- Buffered Outputs Compatible with Discrete Transistor Driver Interface
- Low Power Dissipation

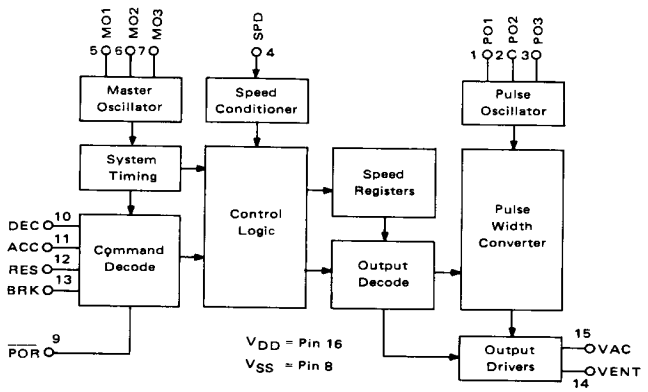


P SUFFIX
PLASTIC PACKAGE
CASE 648

PIN ASSIGNMENT



BLOCK DIAGRAM



This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

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MAXIMUM RATINGS (Voltages referenced to V_{SS})

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	-0.5 to +6.0	Vdc
Input Voltage, All Inputs	V_{in}	-0.5 to V_{DD} + 0.5	Vdc
DC Input Current, per Pin	I_{in}	±10	mAdc
Operating Temperature Range —	T_A	-40 to +85	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = -40°C to +85°C)

Characteristic	Symbol	V_{DD} Vdc	Min	Typ	Max	Unit
Supply Voltage Pin 16	V_{DD}	—	4.0	5.0	6.0	Vdc
Output Voltage Pins 1, 2, 5, 6, 14, 15	V_{OL}	5.0	—	—	0.5	Vdc
	V_{OH}	5.0	4.5	—	—	Vdc
Input Voltage Pins 3, 7, 9, 10, 11, 12, 13	V_{IL}	—	—	—	0.3 V_{DD}	Vdc
	V_{IH}	—	0.7 V_{DD}	—	—	Vdc
Pin 4	V_{IL}	—	$\frac{V_{DD}}{2}$ -1.5	—	—	Vdc
	V_{IH}	—	—	—	$\frac{V_{DD}}{2}$ +1.5	Vdc
Input Hysteresis Pin 4 ($V_{IH} - V_{IL}$)	HYS	—	0.4	—	—	Vdc
Output Drive Current Pins 1, 2, 5, 6 V_{OH} = 4.6 Vdc	I_{OH}	5.0	-0.29	—	—	mAdc
V_{OL} = 0.4 Vdc	I_{OL}	5.0	+0.36	—	—	mAdc
Pins 14, 15 V_{OH} = 2.5 Vdc	I_{OH}	5.0	-2.0	—	—	mAdc
Input Current Pins 3, 4, 7, 10, 11, 12, 13 V_{IL} = 0.0 Vdc	I_{IL}	6.0	—	—	-1.0	μAdc
V_{OH} = 6.0 Vdc	I_{IH}	6.0	—	—	+1.0	μAdc
Pin 9 V_{IL} = 0.0 Vdc	I_{IL}	6.0	15	—	200	μAdc
V_{IH} = 6.0 Vdc	I_{IH}	6.0	—	—	+1.0	μAdc
Supply Current Pin 16 (Both Oscillators Active, VAC and VENT Outputs High)	I_{DD}	6.0	—	1.0	10	mAdc

FIGURE 1 — SYSTEM TIMING

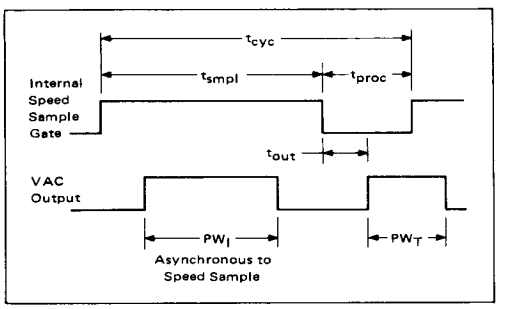
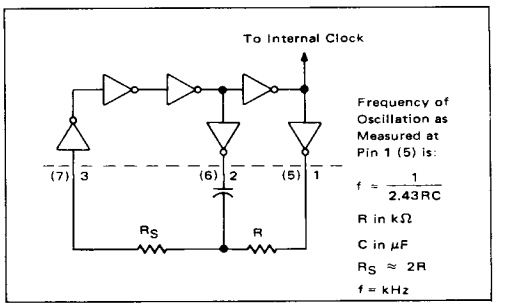


****FIGURE 2 — OSCILLATORS**



SWITCHING CHARACTERISTICS (T_A = 25°C, V_{DD} = 4–6 Vdc)

Characteristics	Symbol	Min	Typ	Max	Unit
ACCEL Input Hold Time	t_{ACC}	$16/f_M$	9.52*	–	ms
DECEL Input Hold Time	t_{DEC}	$16/f_M$	9.52*	–	ms
RESUME Input Hold Time	t_{RES}	1	–	–	μs
BRAKE Input Hold Time	t_{BRK}	1	–	–	μs
Master Oscillator Frequency**					
T_A = -40°C to +85°C, R_S = 100 kΩ					
R = 43 kΩ, C = 5600 pF	f_M	1596	1680	1764	Hz
Useful Range		1344	1680	2016	Hz
Pulse Oscillator Frequency**					
T_A = -40°C to +85°C, R_S = 100 kΩ					
R = 43 kΩ, C = 5600 pF	f_P	1596	1680	1764	Hz
Useful Range		400	1600	3200	Hz
Speed Input Frequency	f_S	–	–	300	Hz
Speed Sample Time ($1008/f_M$)	t_{smpl}	–	600*	–	ms
Speed Processing Time ($16/f_M$)	t_{proc}	–	8.9*	–	ms
System Cycle Time ($1024/f_M$)	t_{cyc}	–	608.9*	–	ms
Output Delay Time ($9/f_M$)	t_{out}	–	5.4*	–	ms
Output Pulse Width					
Initializations (≈1/fp)	PW_I	280*	–	760*	ms
Trim Outputs (≈1/fp)	PW_T	10*	–	80*	ms

*f_M = 1680 Hz, f_P = 1600 Hz, f_S = 2.222 Hz/MPH

SYSTEM PERFORMANCE (T_A = 25°C, V_{DD} = 5 Vdc, f_M = 1680 Hz, f_S = 2.222 Hz/MPH)

Characteristic	Symbol	Typical	Unit
Speed Resolution ($f_M/2016\ f_S$)	S_{RES}	0.375	MPH
Minimum Operating Speed ($f_M/31.5\ f_S$)	S_{min}	24	MPH
Maximum Stored Speed ($f_M/8.4\ f_S$)	S_{max}	90	MPH
Controlled Acceleration Rate (ACCEL or RESUME Modes) $(f_M)^2/f_S\ (6.881)\ (10^5)$	A	1.85	MPH/s
Redundant Brake Speed Drop Below Stored Reference Speed $(-f_M/63\ f_S)$	S_{RB}	-12	MPH
Speed Deviation			
Assumes Suitable Mechanical Hookup and Pulse Oscillator Frequency Adjusted to Suit Throttle Servo Requirements			
Level Road (no wind, ± 1% grades)	ΔS_N	±2	MPH
Transient Road Conditions (± 10 MPH winds, ± 7% grades)	ΔS_T	±3	MPH
Stored Speed Accuracy			
Steady-State (Acceleration = 0)	RS_{SS}	0.375	MPH
Transient (Acceleration = ± A MPH/s)	RS_T	0.6 A	MPH

TRUTH TABLE

OUTPUT		
VAC	VENT	SERVO DRIVE
0	0	Decrease Speed
0	1	Hold Speed
1	0	Invalid Output
1	1	Increase Speed

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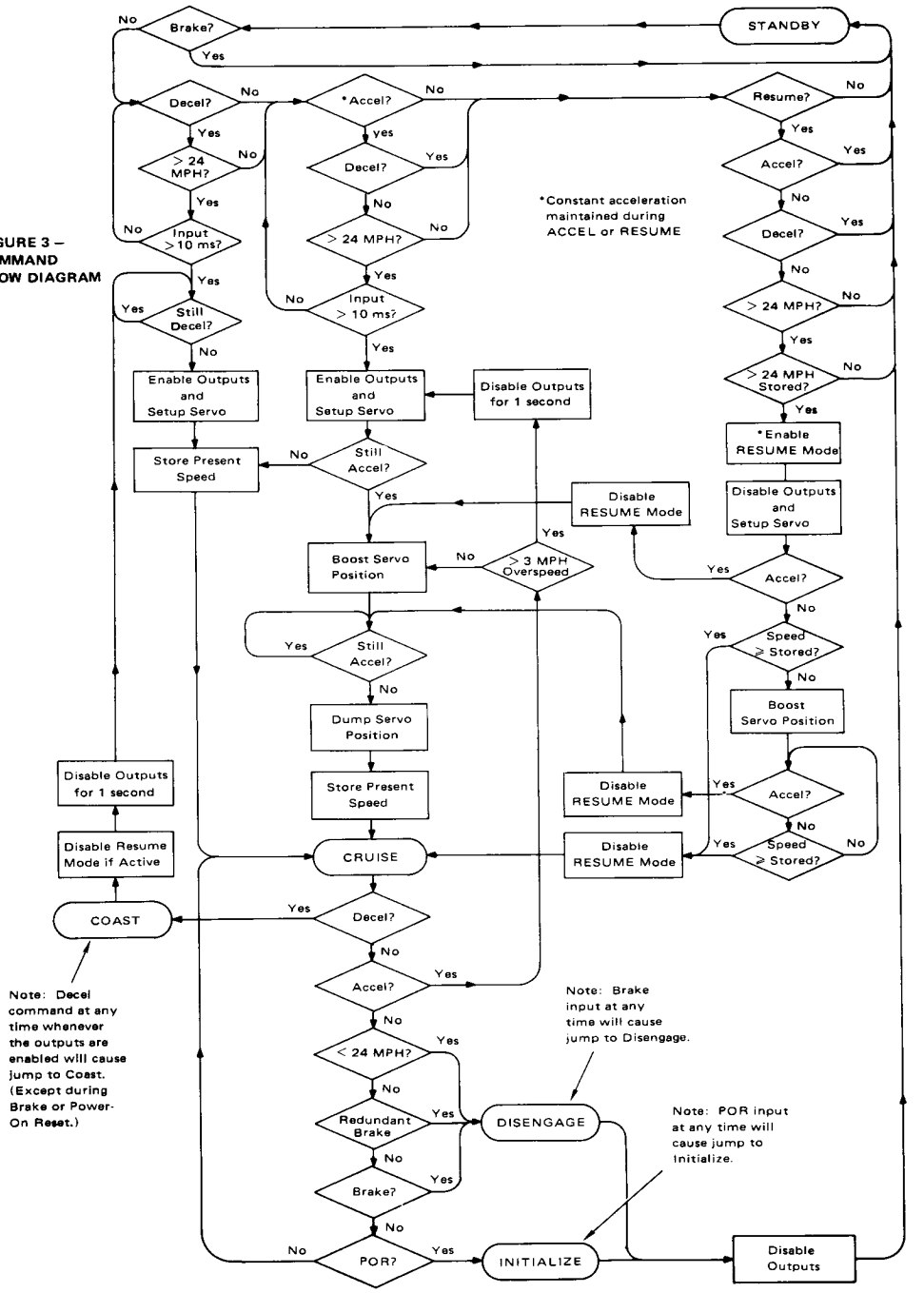

FIGURE 3 – COMMAND FLOW DIAGRAM

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DEVICE OPERATION

PULSE OSCILLATOR (PO1, PO2, PO3; Pins 1, 2, 3)

These pins are the output pins of the output Pulse Oscillator, which is a three-terminal RC type. See Figure 2 for design parameters. This oscillator sets the relative pulse width of the VAC and VENT outputs.

SPEED (SPD, Pin 4)

This is the Speed input to be controlled or stored. This input is level sensitive with hysteresis to allow use of slowly changing waveforms. Input frequency should never exceed 1/3 the Master Oscillator frequency (f_M).

MASTER OSCILLATOR (MO1, MO2, MO3; Pins 5, 6, 7)

The Master Oscillator is a three-terminal RC type. See Figure 2 for design parameters. This oscillator sets the master system timing.

POWER-ON RESET (POR, Pin 9)

This pin is the Power-On Reset input. As long as this input is LOW, the internal system is cleared and the VAC and VENT outputs are disabled. An internal pullup device will source 15–200 μAdc of current from this pin to allow capacitor charging for automatic power-on reset.

DECEL (DEC, Pin 10)

This is the DECEL command input. When held HIGH both VAC and VENT outputs will be LOW. When the DECEL input returns LOW the last sample of the SPD input will be stored as the reference speed. The flow diagram in Figure 3 gives the detailed constraints/operation of this input.

ACCEL (ACC, Pin 11)

This is the ACCEL command input. When held HIGH the VAC and VENT outputs will be modulated to maintain a fixed rate of acceleration. When the ACCEL input returns LOW the last sample of the SPD input will be stored as the reference speed. The flow diagram in Figure 3 gives the detailed constraints/operation of this input.

continued

THROTTLE SERVO

A. Two Coil Vacuum Powered

Truth Table:

VAC Coil	VENT Coil	Throttle Action
Off	Off	Release
Off	On	Hold
On	Off	Weak Pull
On	On	Pull

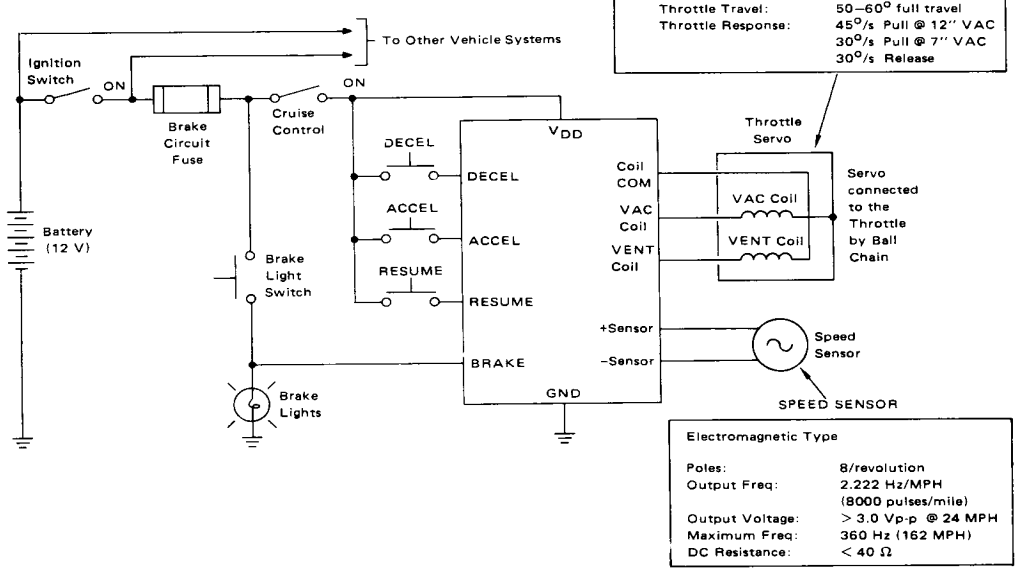
B. Coil Type

Coil Impedance: 80–90 Ω
Coil Inductance: 125–150 mH

C. Servo Response

Minimum Pulse Width: 5 ms
Throttle Travel: 50–60° full travel
Throttle Response: 45°/s Pull @ 12" VAC
30°/s Pull @ 7" VAC
30°/s Release

FIGURE 4 – TYPICAL AUTOMOTIVE CRUISE CONTROL APPLICATION



Electromagnetic Type

Poles:	8/revolution
Output Freq:	2.222 Hz/MPH (8000 pulses/mile)
Output Voltage:	> 3.0 Vp-p @ 24 MPH
Maximum Freq:	360 Hz (162 MPH)
DC Resistance:	< 40 Ω

DEVICE OPERATION continued

RESUME (RES, Pin 12)

This is the RESUME command input. When taken HIGH the system will lock into a mode where the VAC and VENT outputs are modulated to maintain a fixed rate acceleration. This acceleration ends when the SPD input sample matches the stored reference speed. The flow diagram in Figure 3 gives the detailed constraints/operation of this input.

BRAKE (BRK, Pin 13)

This is the BRAKE command input. When this input is taken HIGH the system is disabled (both VAC and VENT outputs LOW) until a DECEL, ACCEL, or RESUME command is received. The flow diagram in Figure 3 gives the detailed constraints/operation of this input.

VENT (Pin 14)

This is the VENT output. See Truth Table for operation.

VAC (Pin 15)

This is the VAC output. See Truth Table for operation.

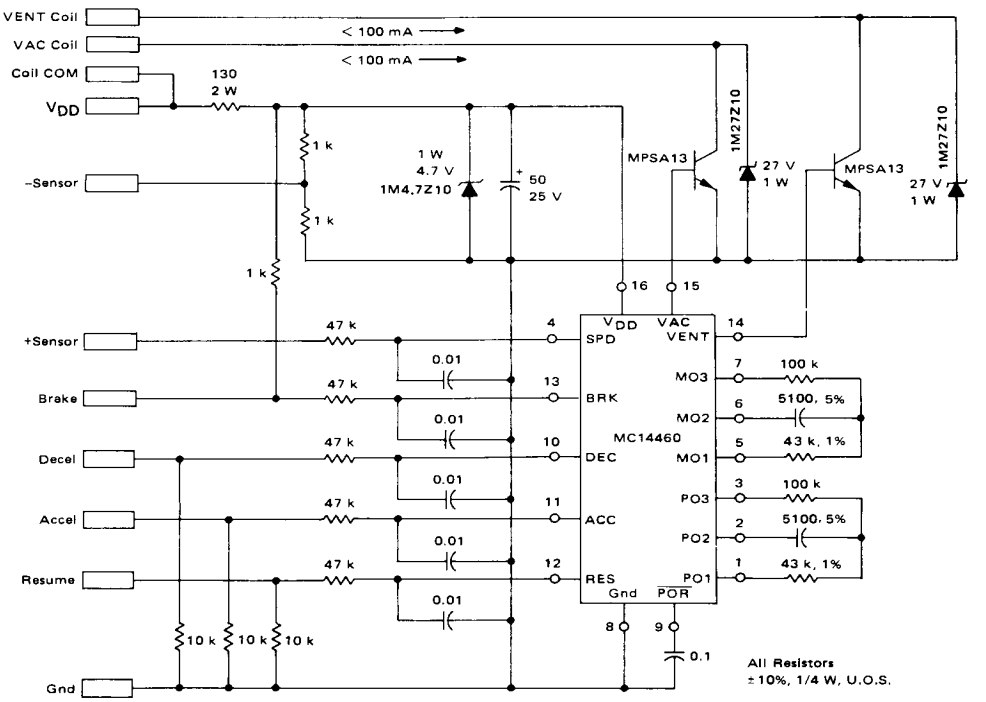
GROUND (V_{SS}, Pin 8)

Pin 8 is the ground connection for the package.

POSITIVE POWER SUPPLY (V_{DD}, Pin 16)

Pin 16 is the power supply connection for the package.

FIGURE 5 – PC BOARD MODULE FOR CRUISE CONTROL



Environment

Ambient Temperature (T_A)	-40°C to 85°C
V_{CC} Operating Range	11–15 Vdc
V_{CC} Transients	9–16 Vdc
Load Dump	80 V Peak decaying to 12 V in < 200 ms
Inductive	±300 V Peak decaying in < 1 ms
Jump Start	+24 Vdc for 5 min.
Reverse Battery	-12 Vdc continuous

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