National Semiconductor

MOS Clock Drivers

DS0025/DS0025C Two-Phase MOS Clock Driver

General Description

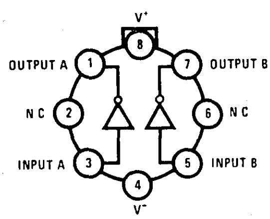
The DS0025/DS0025C is monolithic, low cost, two phase MOS clock driver that is designed to be driven by TTL/DTL line drivers or buffers such as the DM932, DS8830 or DM7440. Two input coupling capacitors are used to perform the level shift from TTL/DTL to MOS logic levels. Optimum performance in turn-off delay and fall time are obtained when the output pulse is logically controlled by the input. However, output pulse widths may be set by selection of the input capacitors eliminating the need for tight input pulse control.

Features

- 8-lead TO-5 or 8-lead dual-in-line package
- High Output Voltage Swings—up to 30V
- High Output Current Drive Capability—up to 1.5A
- Rep. Rate: 1.0 MHz into > 1000 pF
- Driven by DM932, DS8830, DM7440 (SN7440)
- "Zero" Quiescent Power

Connection Diagrams

Metal Can Package

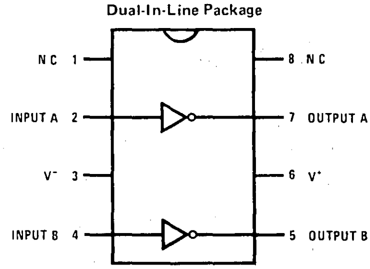


Note: Pin 4 connected to case.

TOP VIEW

Order Number DS0025H or DS0025CH
See NS Package H08C

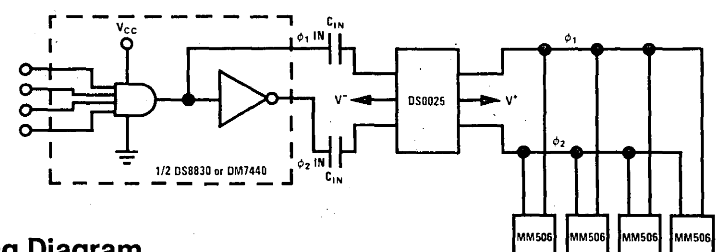
Dual-In-Line Package



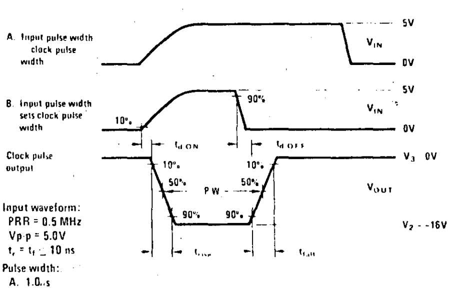
TOP VIEW

Order Number DS0025CN-8
See NS Package N08A

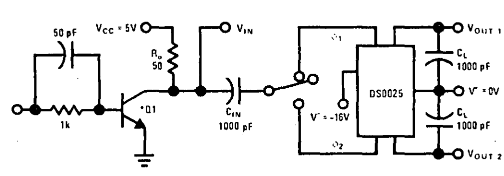
Typical Applications



Timing Diagram



AC Test Circuit



*Q1 is selected high speed NPN switching transistor.

Absolute Maximum Ratings (Note 1)

($V^+ - V^-$) Voltage Differential	30V
Input Current	100 mA
Peak Output Current	1.5A
Storage Temperature	−65°C to +150°C
Operating Temperature DS0025	−55°C to +125°C
DS0025C	0°C to +85°C
Lead Temperature (Soldering, 10 sec)	300°C

Electrical Characteristics (Notes 2 and 3) See test circuit

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
t_{dON}	Turn-On Delay Time	$C_{IN} = 0.001\mu F$, $R_{IN} = 0\Omega$, $C_L = 0.001\mu F$			15	30	ns
t_{RISE}	Rise Time	$C_{IN} = 0.001\mu F$, $R_{IN} = 0\Omega$, $C_L = 0.001\mu F$			25	50	ns
t_{dOFF}	Turn-Off Delay Time	$C_{IN} = 0.001\mu F$, $R_{IN} = 0\Omega$, $C_L = 0.001\mu F$, (Note 4)			30	60	ns
t_{FALL}	Fall Time	$C_{IN} = 0.001\mu F$, $R_{IN} = 0\Omega$,	(Note 4)	60	90	120	ns
		$C_L = 0.001\mu F$	(Note 5)	100	150	250	ns
PW	Pulse Width (50% to 50%)	$C_{IN} = 0.001\mu F$, $R_{IN} = 0\Omega$, $C_L = 0.001\mu F$ (Note 5)			500		ns
V_{O+}	Positive Output Voltage Swing	$V_{IN} = 0V$, $I_{OUT} = -1$ mA		$V^+-1.0$	$V^+-0.7V$		V
V_{O-}	Negative Output Voltage Swing	$I_{IN} = 10$ mA, $I_{OUT} = 1$ mA			$V^-+0.7V$	$V^-+1.5V$	V

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DS0025 and across the 0°C to +70°C range for the DS0025C.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

Note 4: Parameter values apply for clock pulse width determined by input pulse width.

Note 5: Parameter values for input pulse width greater than output clock pulse width.

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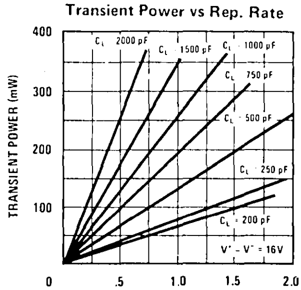
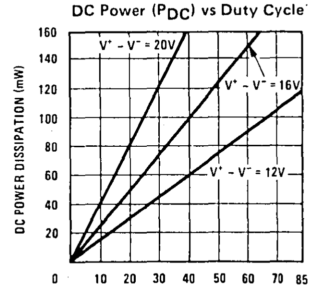
Typical Performance

Transient Power vs Rep. Rate



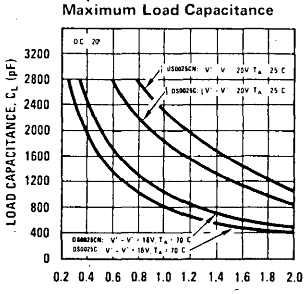
$P_{AC} = (V^+ - V^-)^2 f C_L$

DC Power (P_{DC}) vs Duty Cycle



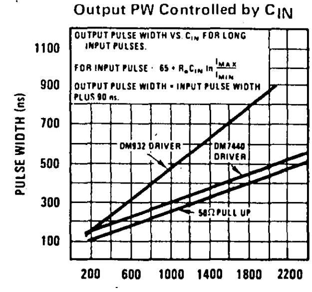
$P_{DC} = \frac{(V^+ - V^-)^2 (DC)}{1k}$

Maximum Load Capacitance



$C_L < \frac{(P_{MAX})(1k) - (V^+ - V^-)^2 (DC)}{(f)(1k)(V^+ - V^-)^2} < \frac{(I_{pk})(t_r)}{V^+ - V^-}$

Output PW Controlled by C_{IN}



I_{MAX} = Peak current delivered by driver

$I_{MIN} \geq \frac{V_{BE}}{R1} = \frac{0.6}{1k}$

Applications Information

Circuit Operation

Input current forced into the base of Q_1 through the coupling capacitor C_{IN} causes Q_1 to be driven into saturation, swinging the output to $V^- + V_{CE}(sat) + V_{Diode}$.

When the input current has decayed, or has been switched, such that Q_1 turns off, Q_2 receives base drive through R_2, turning Q_2 on. This supplies current to the load and the output swings positive to $V^+ - V_{BE}$.

It may be noted that Q_1 must switch off before Q_2 begins to supply current, hence high internal transients currents from V^- to V^+ cannot occur.

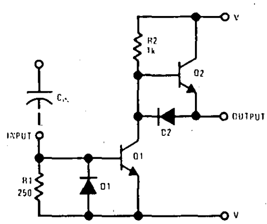


FIGURE 1. DS0025 Schematic (One-Half Circuit)

Fan-Out Calculation

The drive capability of the DS0025 is a function of system requirements, i.e. speed, ambient temperature, voltage swing, drive circuitry, and stray wiring capacity.

The following equations cover the necessary calculations to enable the fan-out to be calculated for any system condition.

Transient Current

The maximum peak output current of the DS0025 is given as 1.5A. Average transient current required from the driver can be calculated from:

$$I = \frac{C_L (V^+ - V^-)}{t_r} \quad (1)$$

Typical rise times into 1000 pF load is 25 ns For $V^+ - V^- = 20V$, $I = 0.8A$.

Transient Output Power

The average transient power (P_{ac}) dissipated, is equal to the energy needed to charge and discharge the output capacitive load (C_L) multiplied by the frequency of operation (f).

$$P_{AC} = C_L \times (V^+ - V^-)^2 \times f \quad (2)$$

For $V^+ - V^- = 20V$, $f = 1.0$ MHz, $C_L = 1000$ pF, $P_{AC} = 400$ mW.

Internal Power

"0" State   Negligible (<3 mW)

"1" State

$$P_{int} = \frac{(V^+ - V^-)^2}{R_2} \times \text{Duty Cycle} \quad (3)$$

$$= 80 \text{ mW for } V^+ - V^- = 20V, \text{ DC} = 20\%$$

Package Power Dissipation

Total average power = transient output power + internal power

Example Calculation

How many MM506 shift registers can be driven by a DS0025CN driver at 1 MHz using a clock pulse width of 200 ns, rise time 30-50 ns and 16V amplitude over the temperature range 0-70°C?

Power Dissipation:

At 70°C the DS0025CN can dissipate 870 mW when soldered into printed circuit board.

Transient Peak Current Limitation:

From equation (1), it can be seen that at 16V and 30 ns, the maximum load that can be driven is limited to 2800 pF.

Average Internal Power:

Equation (3), gives an average power of 50 mW at 16V and a 20% duty cycle.

For one-half of the DS0025C, 870 mW ÷ 2 can be dissipated.

435 mW = 50 mW + transient output power

385 mW = transient output power

Using equation (2) at 16V, 1 MHz and 350 mW, each half of the DS0025CN can drive a 1367 pF load. This is less than the load imposed by the transient current limitation of equation (1) and so a maximum load of 1367 pF would prevail.

From the data sheet for the MM506, the average clock pulse load is 80 pF. Therefore the number of devices driven is 1367/80 or 17 registers.