19-3020; Rev 0; 10/03

MAXIM

20-Output, 76V, Serial-Interfaced VFD Tube Drivers

General Description

The MAX6921/MAX6931 are 20-output, 76V, vacuum-fluorescent display (VFD) tube drivers that interface a multiplexed VFD tube to a VFD controller, such as the MAX6850–MAX6853, or to a microcontroller. The MAX6921/MAX6931 are also ideal for driving static VFD tubes or telecom relays.

Data is input using an industry standard 4-wire serial interface (CLOCK, DATA, LOAD, BLANK), compatibile with either Maxim's or industry-standard VFD driver and controller.

For easy display control, the active-high BLANK input forces all driver outputs low, turning the display off, and automatically puts the MAX6921/MAX6931 into shutdown mode. Display intensity may also be controlled by directly pulse-width modulating the BLANK input.

The MAX6921 has a serial interface data output, DOUT, allowing any number of devices to be cascaded on the same serial interface.

The MAX6931 has a negative supply voltage input, V_{SS}, allowing the drivers' output swing to be made bipolar to simplify filament biasing in many applications.

The MAX6921 is available in 28-pin TSSOP, SO, and PLCC packages. The MAX6931 is available in a 28-pin TSSOP package.

Maxim also offers 12-output VFD drivers (MAX6920) and 32-output VFD drivers (MAX6922/MAX6932).

Applications

- White Goods
- Gaming Machines
- Automotive
- Avionics
- Instrumentation
- Industrial Weighing
- Security
- Telecom
- VFD Modules
- Industrial Control

Pin Configurations appear at end of data sheet.

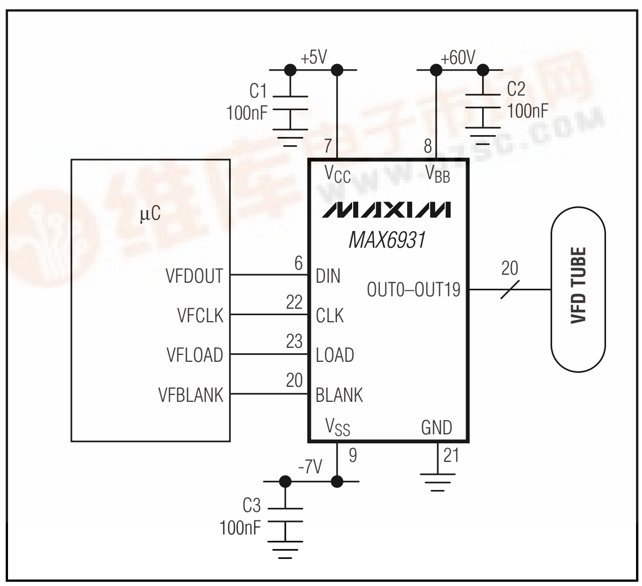
Features

- ♦ **5MHz Industry-Standard 4-Wire Serial Interface**
- ♦ **3V to 5.5V Logic Supply Range**
- ♦ **8V to 76V Grid/Anode Supply Range**
- ♦ **-11V to 0V Filament Bias Supply (MAX6931 Only)**
- ♦ **Push-Pull CMOS High-Voltage Outputs**
- ♦ **Outputs can Source 40mA, Sink 4mA Continuously**
- ♦ **Outputs can Source 75mA Repetitive Pulses**
- ♦ **Outputs can be Paralleled for Higher Current Drive**
- ♦ **Any Output can be Used as a Grid or an Anode Driver**
- ♦ **Blank Input Simplifies PWM Intensity Control**
- ♦ **Small 28-Pin TSSOP Package**
- ♦ **-40°C to +125°C Temperature Range**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX6921AUI	-40°C to +125°C	28 TSSOP
MAX6921AWI	-40°C to +125°C	28 Wide SO
MAX6921AQI	-40°C to +125°C	28 PLCC
MAX6931AUI	-40°C to +125°C	28 TSSOP

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at

20-Output, 76V, Serial-Interfaced VFD Tube Drivers

ABSOLUTE MAXIMUM RATINGS

Voltage (with respect to GND)
V_{BB} ....-0.3V to +80V
V_{CC} ....-0.3V to +6V
V_{SS} (MAX6931 only) ....-12V to +0.3V
V_{BB} - V_{SS} (MAX6931 only) ....-0.3V to +80V
OUT_ (MAX6921 only) ....(GND - -0.3V) to (V_{BB} + 0.3V)
OUT_ (MAX6931 only) ....(V_{SS} - -0.3V) to (V_{BB} + 0.3V)
All Other Pins...-0.3V to (V_{CC} + 0.3V)
OUT_ Continuous Source Current ....-45mA
OUT_ Pulsed (1ms max, 1/4 max duty) Source Current ...-80mA
Total OUT_ Continuous Source Current ....-540mA
Total OUT_ Continuous Sink Current 90mA
Total OUT_ Pulsed (1ms max, 1/4 max duty)
Source Current ....-960mA
OUT_ Sink Current 15mA
CLK, DIN, LOAD, BLANK, DOUT Current ....±10mA
Continuous Power Dissipation (T_A = +70°C)
28-Pin TSSOP (derate 12.8mW/°C over +70°C)...1025mW
28-Pin Wide SO (derate 12.5mW/°C over +70°C)...1000mW
28-Pin PLCC (derate 10.5mW/°C over +70°C)...842mW
Operating Temperature Range
(T_{MIN} to T_{MAX}) ....-40°C to +125°C
Junction Temperature..+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Typical Operating Circuit, V_{BB} = 8V to 76V, V_{CC} = 3V to 5.5V, V_{SS} = -11V to 0V, V_{BB} - V_{SS} ≤ 76V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Logic Supply Voltage	V_{CC}			3		5.5	V
Tube Supply Voltage	V_{BB}			8		76	V
Bias Supply Voltage (MAX6931 Only)	V_{SS}			-11		0	V
Total Supply Voltage (MAX6931 Only)	V_{BB} - V_{SS}					76	V
Logic Supply Operating Current	I_{CC}	All outputs OUT_ low, CLK = idle	T_A = +25°C		78	170	µA
			T_A = -40°C to +125°C			200	
		All outputs OUT_ high, CLK = idle	T_A = +25°C		540	900	
			T_A = -40°C to +125°C			1000	
Tube Supply Operating Current	I_{BB}	All outputs OUT_ low	T_A = +25°C		1.65	3.0	mA
			T_A = -40°C to +125°C			6.9	
		All outputs OUT_ high	T_A = +25°C		0.85	1.3	
			T_A = -40°C to +125°C			1.4	
Bias Supply Operating Current (MAX6931 Only)	I_{SS}	All outputs OUT_ low	T_A = +25°C	-0.8	-0.38		mA
			T_A = -40°C to +125°C	-1.9			
		All outputs OUT_ high	T_A = +25°C	-1.4	-0.87		
			T_A = -40°C to +125°C	-1.5			
High-Voltage OUT_	V_H	V_{BB} ≥ 15V, I_{OUT} = -25mA	T_A = +25°C		V_{BB} - 1.1		V
			T_A = -40°C to +85°C	V_{BB} - 2			
			T_A = -40°C to +125°C	V_{BB} - 2.5			
		V_{BB} ≥ 15V, I_{OUT} = -40mA	T_A = -40°C to +85°C	V_{BB} - 3.5			
			T_A = -40°C to +125°C	V_{BB} - 4.0			
		8V < V_{BB} < 15V, I_{OUT} = -25mA	T_A = +25°C		V_{BB} - 1.2		
			T_A = -40°C to +85°C	V_{BB} - 2.5			
			T_A = -40°C to +125°C	V_{BB} - 3.0			

ELECTRICAL CHARACTERISTICS (continued)

(Typical Operating Circuit, V_{BB} = 8V to 76V, V_{CC} = 3V to 5.5V, V_{SS} = -11V to 0V, V_{BB} - V_{SS} ≤ 76V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Low-Voltage OUT_ (MAX6921 Only)	V_L	V_{BB} ≥ 15V, I_{OUT} = 1mA	T_A = +25°C		0.75	1	V
			T_A = -40°C to +85°C			1.5	
			T_A = -40°C to +125°C			1.9	
		8V < V_{BB} < 15V, I_{OUT} = 1mA	T_A = +25°C		0.8	1.1	
			T_A = -40°C to +85°C			1.6	
			T_A = -40°C to +125°C			2.0	
Low-Voltage OUT_ (MAX6931 Only)	V_L	V_{BB} ≥ 15V, I_{OUT} = 1mA	T_A = +25°C		V_{SS} + 0.75	V_{SS} + 1	V
			T_A = -40°C to +85°C			V_{SS} + 1.5	
			T_A = -40°C to +125°C			V_{SS} + 1.9	
		8V < V_{BB} < 15V, I_{OUT} = 1mA	T_A = +25°C		V_{SS} + 0.8	V_{SS} + 1.1	
			T_A = -40°C to +85°C			V_{SS} + 1.6	
			T_A = -40°C to +125°C			V_{SS} + 2.0	
Rise Time OUT_ (20% to 80%)	t_R	V_{BB} = 60V, C_L = 50pF, R_L =2.3kΩ			0.9	2	µs
Fall Time OUT_ (80% to 20%)	t_F	V_{BB} = 60V, C_L = 50pF, R_L =2.3kΩ			0.6	1.5	µs
SERIAL INTERFACE TIMING CHARACTERISTICS							
LOAD Rising to OUT_ Falling Delay		(Notes 2, 3)			0.9	1.8	µs
LOAD Rising to OUT_ Rising Delay		(Notes 2, 3)			1.2	2.4	µs
BLANK Rising to OUT_ Falling Delay		(Notes 2, 3)			0.9	1.8	µs
BLANK Falling to OUT_ Rising Delay		(Notes 2, 3)		0.5	1.3	2.5	µs
Input Leakage Current CLK, DIN, LOAD, BLANK	I_{IH}, I_{IL}				0.05	10	µA
Logic-High Input Voltage CLK, DIN, LOAD, BLANK	V_{IH}			0.8 x V_{CC}			V
Logic-Low Input Voltage CLK, DIN, LOAD, BLANK	V_{IL}					0.3 x V_{CC}	V
Hysteresis Voltage DIN, CLK, LOAD, BLANK	ΔV_I				0.6		V
High-Voltage DOUT	V_{OH}	I_{SOURCE} = -1.0mA		V_{CC} - 0.5			V
Low-Voltage DOUT	V_{OL}	I_{SINK} = 1.0mA				0.5	V

20-Output, 76V, Serial-Interfaced VFD Tube Drivers

ELECTRICAL CHARACTERISTICS (continued)

(Typical Operating Circuit, V_{BB} = 8V to 76V, V_{CC} = 3V to 5.5V, V_{SS} = -11V to 0V, V_{BB} - V_{SS} ≤ 76V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Note 1)

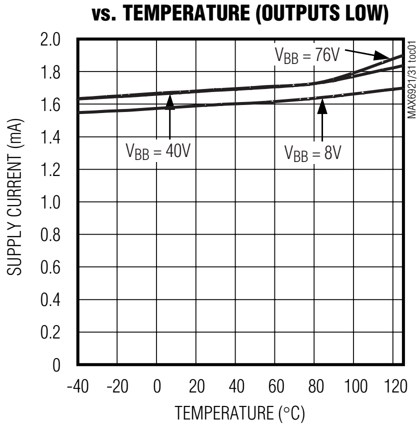
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Rise and Fall Time DOUT		C_{DOUT} = 10pF (Note 2)	3V to 4.5V		60	100	ns
			4.5V to 5.5V		30	80	
CLK Clock Period	t_{CP}			200			ns
CLK Pulse-Width High	t_{CH}			90			ns
CLK Pulse-Width Low	t_{CL}			90			ns
CLK Rise to LOAD Rise Hold	t_{CSH}	(Note 2)		100			ns
DIN Setup Time	t_{DS}			5			ns
DIN Hold Time	t_{DH}	3.0V to 4.5V		20			ns
		4.5V to 5.5V		15			
DOUT Propagation Delay	t_{DO}	C_{DOUT} = 10pF	3.0V to 4.5V	25	120	240	ns
			4.5V to 5.5V	20	75	150	
LOAD Pulse High	t_{CSW}			55			ns

Note 1: All parameters are tested at T_A = +25°C. Specifications over temperature are guaranteed by design.
Note 2: Guaranteed by design.
Note 3: Delay measured from control edge to when output OUT_ changes by 1V.

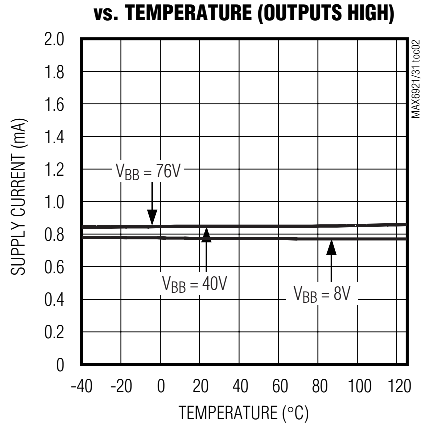
Typical Operating Characteristics

(V_{CC} = 5.0V, V_{BB} = 76V, and T_A = +25°C, unless otherwise noted.)

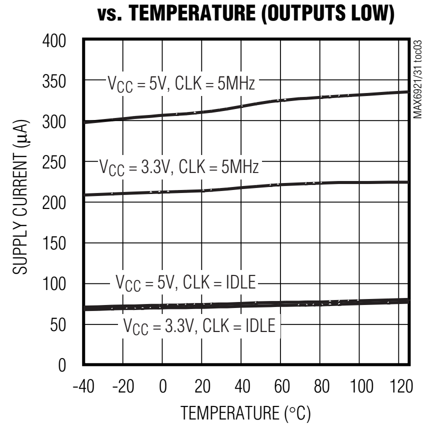
TUBE SUPPLY CURRENT (I_{BB}) vs. TEMPERATURE (OUTPUTS LOW)



TUBE SUPPLY CURRENT (I_{BB}) vs. TEMPERATURE (OUTPUTS HIGH)

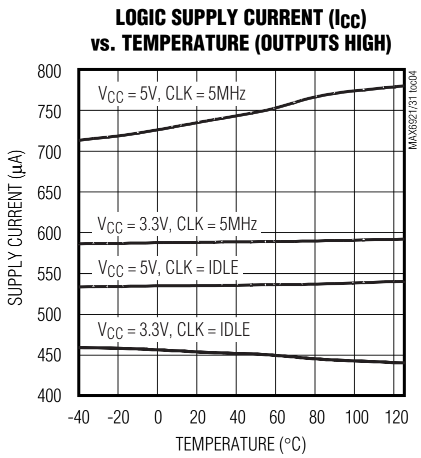


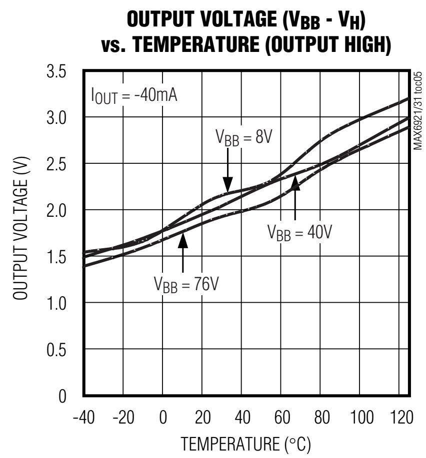
LOGIC SUPPLY CURRENT (I_{CC}) vs. TEMPERATURE (OUTPUTS LOW)

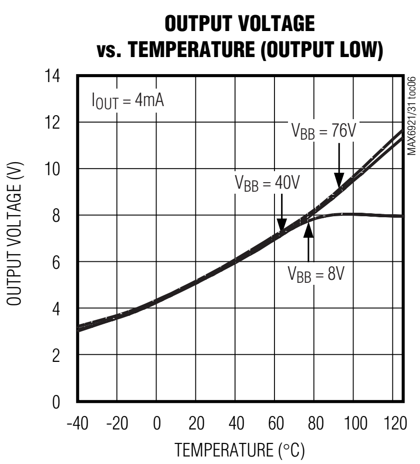


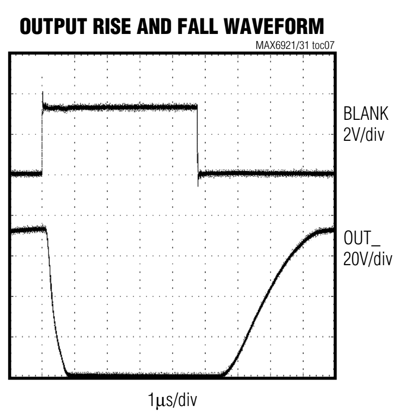
Typical Operating Characteristics (continued)

(V_{CC} = 5.0V, V_{BB} = 76V, and T_A = +25°C, unless otherwise noted.)









Pin Description

PIN			NAME	FUNCTION
TSSOP		WIDE SO/ PLCC		
MAX6931	MAX6921			
1–5, 10–19, 24–28	—	—	OUT0 to OUT19	VFD Anode and Grid Drivers. OUT0 to OUT19 are push-pull outputs swinging from V_{BB} to V_{SS}.
—	1–5, 10–19, 24–28	3–12, 17–26	OUT0 to OUT19	VFD Anode and Grid Drivers. OUT0 to OUT19 are push-pull outputs swinging from V_{BB} to GND.
—	9	2	DOUT	Serial-Clock Output. Data is clocked out of the internal shift-register to DOUT on CLK's rising edge.
6	6	27	DIN	Serial-Data Input. Data is loaded into the internal shift register on CLK's rising edge.
7	7	28	V_{CC}	Logic Supply Voltage
8	8	1	V_{BB}	VFD Tube Supply Voltage
9	—	—	V_{SS}	Filament Bias Supply Voltage
20	20	13	BLANK	Blanking Input. High forces outputs OUT0 to OUT19 low, without altering the contents of the output latches. Low enables outputs OUT0 to OUT19 to follow the state of the output latches.
21	21	14	GND	Ground
22	22	15	CLK	Serial-Clock Input. Data is loaded into the internal shift register on CLK's rising edge.
23	23	16	LOAD	Load Input. Data is loaded transparently from the internal shift register to the output latch while LOAD is high. Data is latched into the output latch on LOAD's rising edge, and retained while LOAD is low.

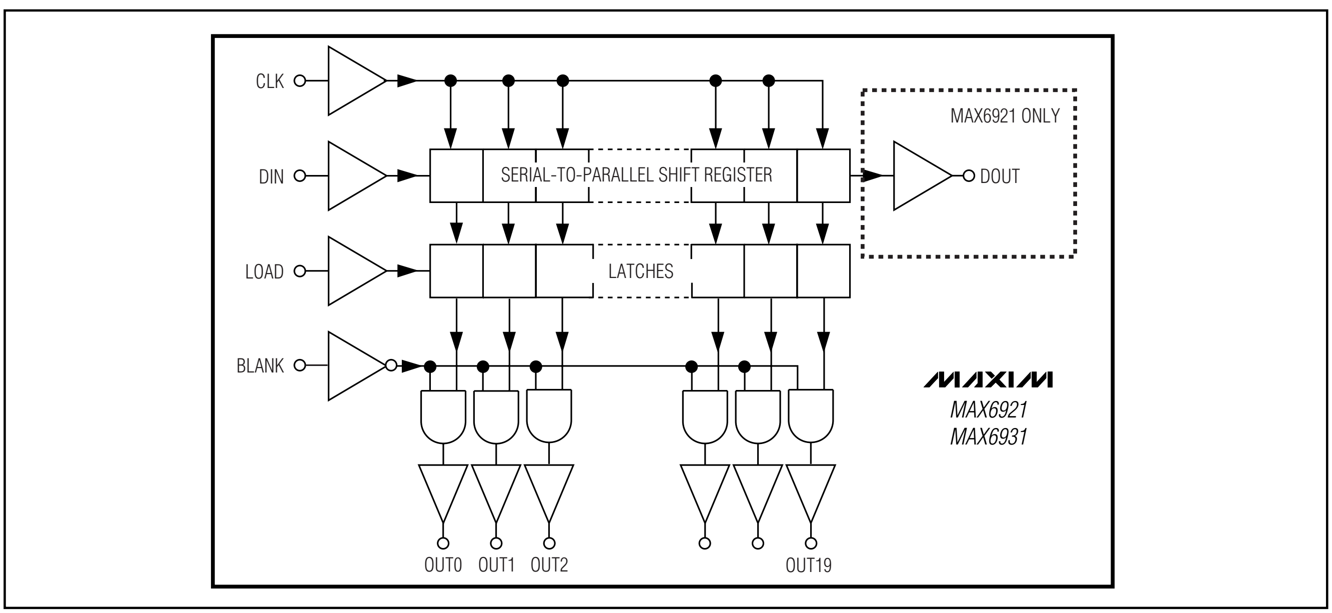


Figure 1. MAX6921/MAX6931 Functional Diagram

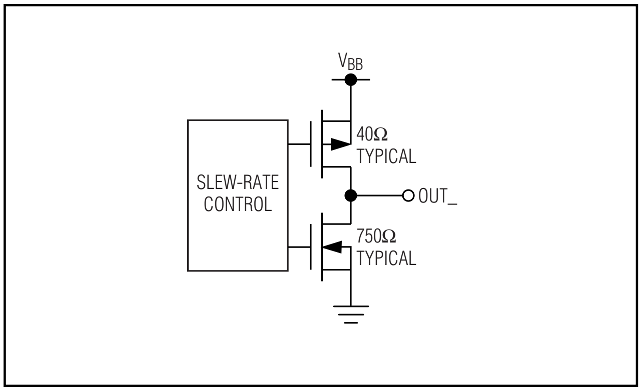


Figure 2. MAX6921 CMOS Output Driver Structure

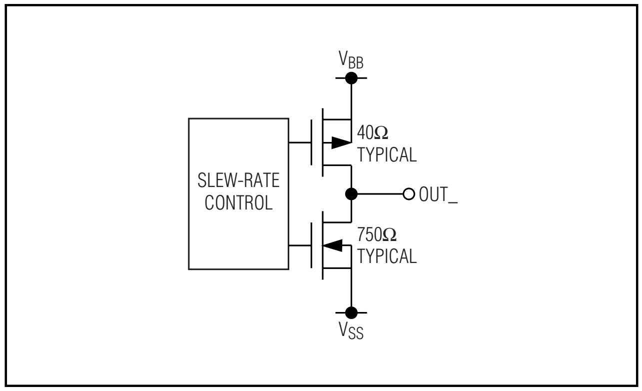


Figure 3. MAX6931 CMOS Output Driver Structure

Detailed Description

The MAX6921/MAX6931 are VFD tube drivers comprising a 4-wire serial interface driving 20 high-voltage Rail-to-Rail® output ports. The driver is suitable for both static and multiplexed displays.

The output ports feature high current-sourcing capability to drive current into grids and anodes of static or multiplex VFDs. The ports also have active current sinking for fast discharge of capacitive display electrodes in multiplexing applications.

The 4-wire serial interface comprises a 20-bit shift register and a 20-bit transparent latch. The shift register is written through a clock input CLK and a data input DIN. For the MAX6921, the data propagates to a data output DOUT. The data output allows multiple drivers to be cascaded and operated together. The output latch is transparent to the shift register outputs when LOAD is high, and latches the current state on the falling edge of LOAD.

Each driver output is a slew-rated controlled CMOS push-pull switch driving between V_{BB} and GND (MAX6921) or V_{SS} (MAX6931). The output rise time is always slower than the output fall time to avoid shoot-through currents during output transitions. The output slew rates are slow enough to minimize EMI, yet are fast enough so as not to impact the typical 100µs digit multiplex period and affect the display intensity.

Initial Power-Up and Operation

An internal reset circuit clears the internal registers of the MAX6921/MAX6931 on power-up. All outputs OUT0 to OUT19 and the interface output DOUT (MAX6921 only) initialize low regardless of the initial logic levels of the CLK, DIN, BLANK, and LOAD inputs.

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

4-Wire Serial Interface

The MAX6921/MAX6931 use 4-wire serial interface with three inputs (DIN, CLK, LOAD) and a data output (DOUT, MAX6921 only). This interface is used to write output data to the MAX6921/MAX6931 (Figure 4) (Table 1). The serial interface data word length is 20 bits, D0–D19.

The functions of the four serial interface pins are:

- CLK input is the interface clock, which shifts data into the MAX6921/MAX6931s' 20-bit shift register on its rising edge.
- LOAD input passes data from the MAX6921/MAX6931s' 20-bit shift register to the 20-bit output latch when LOAD is high (transparent latch), and latches the data on LOAD's falling edge
- DIN is the interface data input, and must be stable when it is sampled on the rising edge of CLK.
- DOUT is the interface data output, which shifts data out from the MAX6921's 20-bit shift register on the rising edge of CLK. Data at DIN is propagated through the shift register and appears at DOUT (20 CLK cycles + t_{DO}) later.

A fifth input, BLANK, can be taken high to force outputs OUT0 to OUT19 low, without altering the contents of the output latches. When the BLANK input is low, outputs OUT0 to OUT19 follow the state of the output latches. A common use of the BLANK input is PWM intensity control.

The BLANK input's function is independent of the operation of the serial interface. Data can be shifted into the serial interface shift register and latched regardless of the state of BLANK.

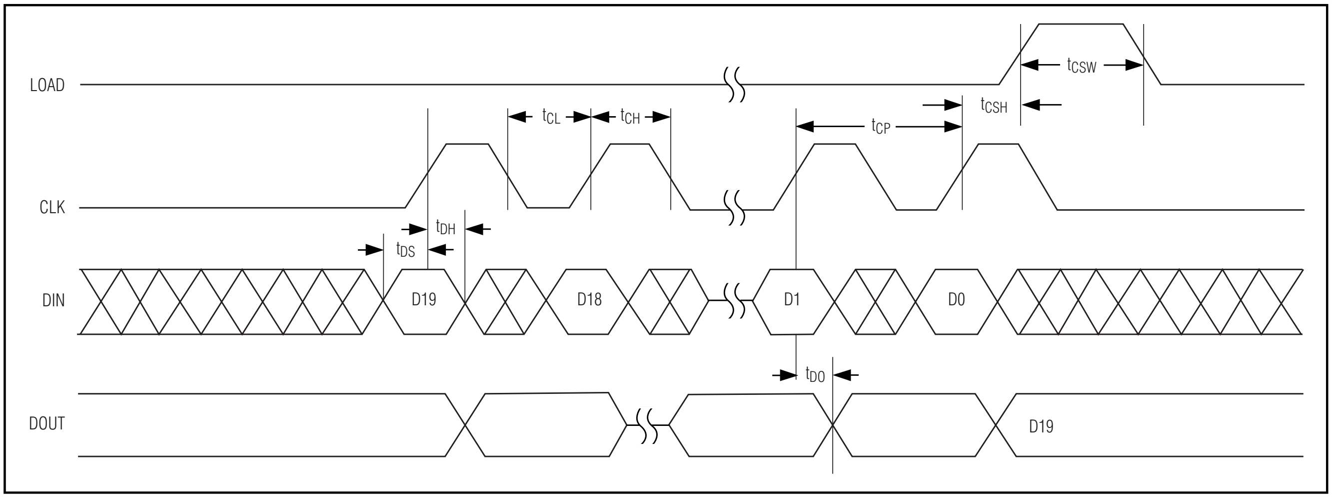


Figure 4. 4-Wire Serial Interface Timing Diagram

Table 1. 4-Wire Serial Interface Truth Table

SERIAL DATA INPUT DIN	CLOCK INPUT	SHIFT REGISTER CONTENTS						LOAD INPUT	LATCH CONTENTS						BLANKING INPUT	OUTPUT CONTENTS					
	CLK	D0	D1	D2	…	Dn-1	Dn	LOAD	D0	D1	D2	…	Dn-1	Dn	BLANK	D0	D1	D2	…	Dn-1	Dn
H	↑ (rising edge)	H	R0	R1	…	Rn-2	Rn-1														
L	↑ (rising edge)	L	R0	R1	…	Rn-2	Rn-1														
X	↓ (falling edge)	R0	R1	R2	…	Rn-1	Rn														
		X	X	X	…	X	X	L	R0	R1	R2	…	Rn-1	Rn							
		P0	P1	P2	…	Pn-1	Pn	H	P0	P1	P2	…	Pn-1	Pn	L	P0	P1	P2	…	Pn-1	Pn
									X	X	X	…	X	X	H	L	L	L	…	L	L

L = Low logic level.
H = High logic level.
X = Don't care.
P = Present state (shift register).
R = Previous state (latched).

Writing Device Registers Using the 4-Wire Serial Interface

The MAX6921/MAX6931 are normally written using the following sequence:

1) Take CLK low.
2) Clock 20 bits of data in order D19 first to D0 last into DIN, observing the data setup and hold times.
3) Load the 20 output latches with a falling edge on LOAD.

LOAD may be high or low during a transmission. If LOAD is high, then the data shifted into the shift register at DIN appear at the OUT0 to OUT19 outputs.

CLK and DIN may be used to transmit data to other peripherals. Activity on CLK always shifts data into the MAX6921/MAX6931s' shift register. However, the MAX6921/MAX6931 only update their output latch on the rising edge of LOAD, and the last 20 bits of data are loaded. Therefore, multiple devices can share CLK and DIN, as long as they have unique LOAD controls.

Determining Driver Output Voltage Drop

The outputs are CMOS drivers, and have a resistive characteristic. The typical and maximum sink and source output resistances can be calculated from the V_H and V_L electrical characteristics. Use this calculated resistance to determine the output voltage drop at different output currents.

Output Current Ratings

The continuous current-source capability is 40mA per output. Outputs may drive up to 75mA as a repetitive peak current, subject to the on-time (output high) being no longer than 1ms, and the duty cycle being such that the output power dissipation is no more than the dissipation for the continuous case. The repetitive peak rating allows outputs to drive a higher current in multiplex grid driver applications, where only one grid is on at a time, and the multiplex time per grid is no more than 1ms.

Since dissipation is proportional to current squared, the maximum current that can be delivered for a given multiplex ratio is given by:

$$I_{PEAK} = (\text{grids} \times 1600)^{1/2} \text{ mA}$$

where grids is the number of grids in a multiplexed display.

This means that a duplex application (two grids) can use a repetitive peak current of 56.5mA, a triplex (three grids) application can use a repetitive peak current of 69.2mA, and higher multiplex ratios are limited to 75mA.

Paralleling Outputs

Any number of outputs within the same package may be paralleled in order to raise the current drive or reduce the output resistance. Only parallel outputs directly (by shorting outputs together) if the interface control can be guaranteed to set the outputs to the same level. Although the sink output is relatively weak (typically 750Ω), that resistance is low enough to dissipate 530mW when shorted to an opposite level output at a V_{BB} voltage of only 20V. A safe way to parallel outputs is to use diodes to prevent the outputs from sinking current (Figure 5). Because the outputs cannot sink current from the VFD tube, an external discharge resistor, R, is required. For static tubes, R can be a large value such as 100kΩ. For multiplexed tubes, the value of the resistor can be determined by the load capacitance and timing characteristics required. Resistor R discharges tube capacitance C to 10% of the initial voltage in 2.3 x RC seconds. So, for example, a 15kΩ value for R discharges 100pF tube grid or anode from 40V to 4V in 3.5µs, but draws an additional 2.7mA from the driver when either output is high.

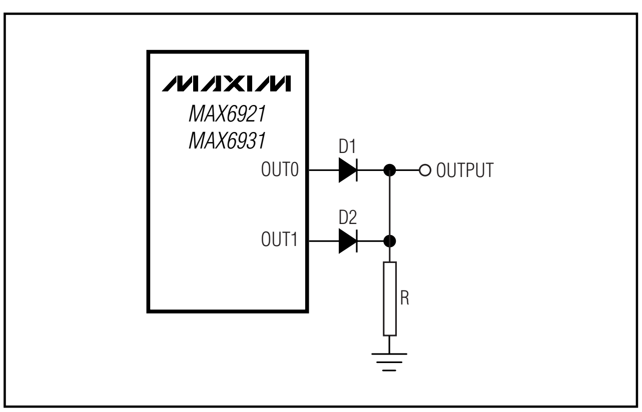


Figure 5. Paralleling Outputs

Power Dissipation

Take care to ensure that the maximum package dissipation ratings for the chosen package are not exceeded. Over-dissipation is unlikely to be an issue when driving static tubes, but the peak currents are usually higher for multiplexed tubes. When using multiple driver devices, try to share the average dissipation evenly between the drivers.

Determine the power dissipation (P_D) for the MAX6921/MAX6931 for static tube drivers with the following equation:

$$P_D = (V_{CC} \times I_{CC}) + (V_{BB} \times I_{BB}) + ((V_{BB} - V_H) \times I_{ANODE} \times A))$$

where:

A = number of anodes driven (the MAX6921/MAX6931 can drive a maximum of 20).

I_{ANODE} = maximum anode current.

(V_{BB} - V_H) is the output voltage drop at the given maximum anode current I_{OUT}.

A static tube dissipation example follows:

V_{CC} = 5V ±5%, V_{BB} = 10V to 18V, A = 20, I_{OUT} = 2mA

$$PD = (5.25V \times 1mA) + (18V \times 1.4mA) + ((2.5V \times 2mA/25mA) \times 2mA \times 20) = 38mW$$

Determine the power dissipation (P_D) for the MAX6921/MAX6931 for multiplex tube drivers with the following equation:

$$P_D = (V_{CC} \times I_{CC}) + (V_{BB} \times I_{BB}) + ((V_{BB} - V_H) \times I_{ANODE} \times A) + ((V_{BB} - V_H) \times I_{GRID}))$$

where:

A = number of anodes driven.

G = number of grids driven.

I_{ANODE} = maximum anode current.

I_{GRID} = maximum grid current.

The calculation presumes all anodes are on, but only one grid is on. The calculated P_D is the worst case, presuming one digit is always being driven with all its anodes lit. Actual P_D can be estimated by multiplying this P_D figure by the actual tube drive duty cycle, taking into account interdigit blanking and any PWM intensity control.

20-Output, 76V, Serial-Interfaced VFD Tube Drivers

A multiplexed tube dissipation example follows:

V_{CC} = 5V ±5%, V_{BB} = 36V to 42V, A = 12, G = 8, I_{ANODE} = 0.4mA, I_{GRID} = 24mA

P_D = (5.25V x 1mA)+ (42V x 1.4mA) + ((2.5V x 0.4mA/25mA) x 0.4mA x 12) + ((2.5V x 24mA/25mA) x 24mA) = 122mW

Thus, for a 28-pin wide TSSOP package (T_{JA} = 1 / 0.0128 = 78.125°C/W from *Absolute Maximum Ratings*), the maximum allowed ambient temperature T_A is given by:

$T_{J(MAX)} = T_A + (P_D \times T_{JA})$ = 150°C = T_A + (0.122 x 78.125°C/W)

So T_A = +140.5°C.

This means that the driver can be operated in this application up to the MAX6921/MAX6931s' +125°C maximum operating temperature.

Power-Supply Considerations

The MAX6921/MAX6931 operate with multiple power-supply voltages. Bypass the V_{CC}, V_{BB}, and V_{SS} (MAX6931 only) power-supply pins to GND with 0.1µF capacitors close to the device. The MAX6931 may be operated with V_{SS} tied to GND if a negative bias supply is not required. For multiplex applications, it may be necessary to add an additional bulk electrolytic capacitor of 1µF or greater to the V_{BB} supply.

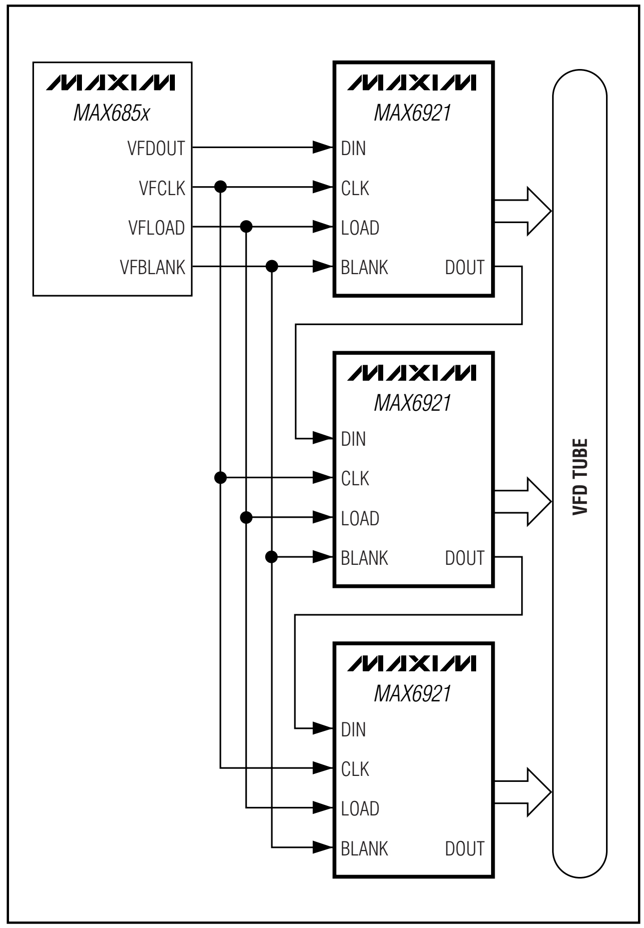
Power-Supply Sequencing

The order of the power-supply sequencing is not important. The MAX6921/MAX6931 will not be damaged if any combination of V_{CC}, V_{BB}, and V_{SS} (MAX6931 only) is grounded while the other supply or supplies are maintained up to their maximum ratings. However, as with any CMOS device, do not drive the MAX6921/MAX6931s' logic inputs if the logic supply V_{CC} is not operational because the input protection diodes clamp the signals.

Cascading Drivers (MAX6921 Only)

Multiple MAX6921s may be cascaded, as shown in the *Typical Application Circuit*, by connecting each driver's DOUT to DIN of the next drivers. Devices may be cascaded at the full 5MHz CLK speed when V_{CC} ≥ 4.5V. When V_{CC} <4.5V, the longer propagation delay (t_{DO}) limits the maximum cascaded CLK to 4MHz.

Typical Application Circuit

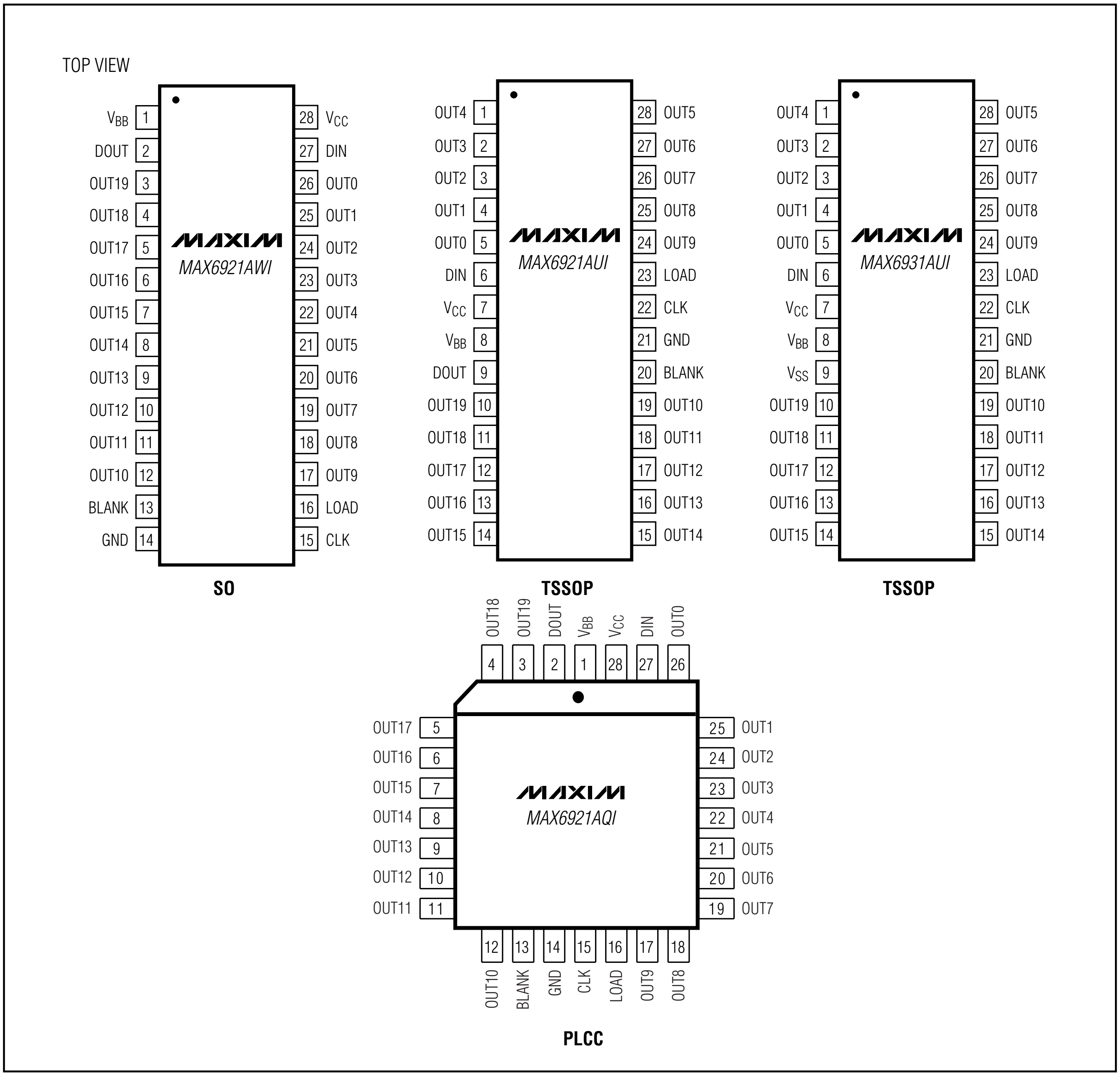


Chip Information

TRANSISTOR COUNT: 2743

PROCESS: BiCMOS

Pin Configurations

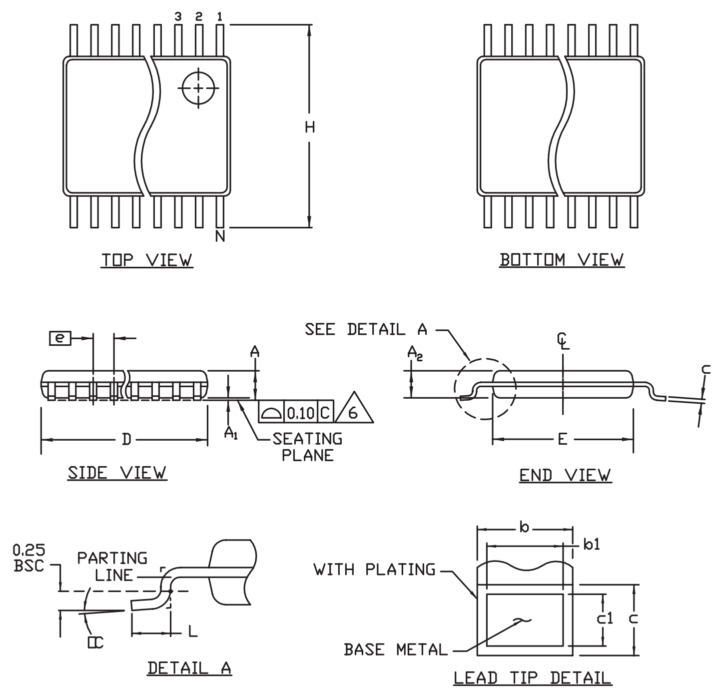


20-Output, 76V, Serial-Interfaced VFD Tube Drivers

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

TSSOP4.40mm.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	—	1.10		.043
A_1	0.05	0.15	.002	.006
A_2	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b_1	0.19	0.25	.007	.010
c	0.09	0.20	.004	.008
c_1	0.09	0.14	.004	.006
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.55	.246	.258
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

JEDEC			VARIATIONS			
MO-153	N		MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
AB-1	14	D	4.90	5.10	.193	.201
AB	16	D	4.90	5.10	.193	.201
AC	20	D	6.40	6.60	.252	.260
AD	24	D	7.70	7.90	.303	.311
AE	28	D	9.60	9.80	.378	.386

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE
5. "N" REFERS TO NUMBER OF LEADS
6. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

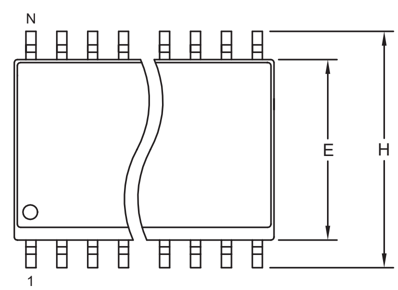
TITLE: PACKAGE OUTLINE, TSSOP 4.40mm BODY

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0066	F	1/1

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SOICW.EPS

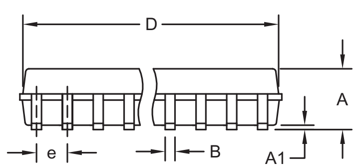


TOP VIEW

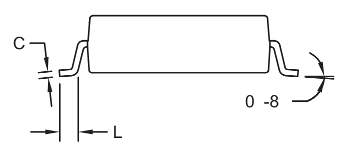
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
e	0.050		1.27	
E	0.291	0.299	7.40	7.60
H	0.394	0.419	10.00	10.65
L	0.016	0.050	0.40	1.27

VARIATIONS:

	INCHES		MILLIMETERS			
DIM	MIN	MAX	MIN	MAX	N	MS013
D	0.398	0.413	10.10	10.50	16	AA
D	0.447	0.463	11.35	11.75	18	AB
D	0.496	0.512	12.60	13.00	20	AC
D	0.598	0.614	15.20	15.60	24	AD
D	0.697	0.713	17.70	18.10	28	AE



FRONT VIEW



SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS013.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE:

PACKAGE OUTLINE, .300" SOIC

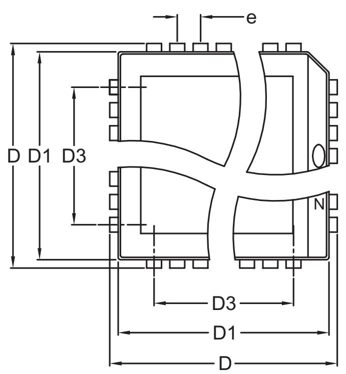
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0042	B	1/1

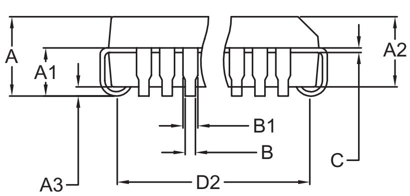
20-Output, 76V, Serial-Interfaced VFD Tube Drivers

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

PLCC.EPS





	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.165	0.180	4.20	4.57
A1	0.090	0.120	2.29	3.04
A2	0.145	0.156	3.69	3.96
A3	0.020	---	0.51	---
B	0.013	0.021	0.33	0.53
B1	0.026	0.032	0.66	0.81
C	0.009	0.011	0.23	0.28
e	0.050		1.27	

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MO047
D	0.385	0.395	9.78	10.03	20	AA
D1	0.350	0.356	8.89	9.04		
D2	0.290	0.330	7.37	8.38		
D3	0.200 REF		5.08 REF			
D	0.485	0.495	12.32	12.57	28	AB
D1	0.450	0.456	11.43	11.58		
D2	0.390	0.430	9.91	10.92		
D3	0.300 REF		7.62 REF			
D	0.685	0.695	17.40	17.65	44	AC
D1	0.650	0.656	16.51	16.66		
D2	0.590	0.630	14.99	16.00		
D3	0.500 REF		12.70 REF			
D	0.785	0.795	19.94	20.19	52	AD
D1	0.750	0.756	19.05	19.20		
D2	0.690	0.730	17.53	18.54		
D3	0.600 REF		15.24 REF			
D	0.985	0.995	25.02	25.27	68	AE
D1	0.950	0.958	24.13	24.33		
D2	0.890	0.930	22.61	23.62		
D3	0.800 REF		20.32 REF			

NOTES:

1. D1 DOES NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .20mm (.008") PER SIDE.
3. LEADS TO BE COPLANAR WITHIN .10mm.
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MO047-XX AS SHOWN IN TABLE.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: FAMILY PACKAGE OUTLINE: 20L, 28L, 44L, 52L, 68L PLCC

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0049	D	1/1

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