

DS38C86A

CMOS BTL 9-Bit Latching Data Transceiver

General Description

The DS38C86A is a 9-bit BTL Latching Data Transceiver designed specifically for proprietary bus interfaces. The device is implemented in CMOS technology, and delivers all of the performance of its Bi-CMOS counterparts while consuming less than half of the power supply current of the DS3886A. The DS38C86A conforms to the IEEE 11941.1 (Backplane Transceiver Logic - BTL) Standard.

The DS38C86A incorporates an edge-triggered latch in the driver path which can be bypassed during fall-through mode of operation and a transparent latch in the receiver path. The DS38C86A driver output configuration is an open drain which allows Wired-OR connection on the bus. A unique design reduces the bus loading to 3 pF typical. The driver also has high sink current capability to comply with the bus loading requirements defined within IEEE 11941.1 BTL specification.

Backplane Transceiver Logic (BTL) is a signaling standard that was invented and first introduced by National Semiconductor, then developed by the IEEE to enhance the performance of backplane buses. BTL transceivers feature low output capacitance drivers to minimize bus loading, a 1V nominal signal swing for reduced power consumption and receivers with precision thresholds for maximum noise immunity. The BTL standard eliminates settling time delays that severely limit TTL bus performance, and thus provide significantly higher bus transfer rates. The backplane bus is intended to be operated with termination resistors (selected to match the bus impedance) connected to a 2.1V at both ends. The low voltage is typically 1V.

The DS38C86A provides an alternative to high power Bipolar and BiCMOS devices with the use of CMOS technology. The CMOS technology enables the DS38C86A to operate at 50% of the I_{CC} required by the Bi-CMOS DS3886A. This can have a major impact on system power consumption. For example, if a backplane is 128 bits wide, 16 devices (9 bits each) required per card. Also assume the backplane is one rack with 20 slots. Power dissipation savings for this application is calculated by the following equation:

$$P = I_{CC}\text{-savings} \times \text{Power supply voltage} \times \text{number of devices}$$

$$P = 32 \text{ mA} \times 5.5 \text{ V} \times 320 = 56 \text{ Watts}$$

The power dissipation savings may increase even more when; the system bus is wider than 128 bits, there are multiple racks in the system, or if the system includes a hot backup. This may double the power dissipation savings.

Separate ground pins are provided for each BTL output minimize induced ground noise during simultaneous switching.

The unique driver circuitry provides a maximum slew rate of 0.9V/ns which allows controlled rise and fall times to reduce noise coupling to adjacent lines.

The transceiver's high impedance control and driver inputs are fully TTL compatible.

The receiver is a high speed comparator that utilizes a Band-gap reference for precision threshold control allowing maximum immunity to the BTL 1V signaling level.

Separate QV_{CC} and $QGND$ pins are provided to minimize the effects of high current switching noise. The receiver output is TRI-STATE® and fully TTL compatible.

The DS38C86A supports live insertion as defined in IEEE 896.2 through the LI (Live Insertion) pin. To implement live insertion the LI pin should be connected to the live insertion power connector. If this function is not supported, the LI pin must be tied to the V_{CC} pin. The DS38C86A also provides glitch free power up/down protection during power sequencing.

The DS38C86A has two types of power connections in addition to the LI pin. They are the Logic V_{CC} (V_{CC}) and the Quiet V_{CC} (QV_{CC}). There are two Logic V_{CC} pins on the DS38C86A that provide the supply voltage for the logic and control circuitry. Multiple connections are provided to reduce the effects of package inductance and thereby minimize switching noise. A voltage delta between V_{CC} and QV_{CC} should never exceed $\pm 0.5\text{V}$ because of ESD circuitry.

When CD (Chip Disable) is high, An is in high impedance state and Bn is high. To transmit data (An to Bn), the T/\bar{R} signal is high.

When RBYP is high, the positive edge triggered flip-flop is in the transparent mode. When RBYP is low, the positive edge of the ACLK signal clocks the data.

In addition, the ESD circuitry between the V_{CC} pins and all other pins except for BTL I/O's and LI pins requires that any voltage on these pins should not exceed the voltage on V_{CC} +0.5V.

There are three different types of ground pins on the DS38C86A; the logic ground (GND), BTL grounds (B0GND-B8GND) and the Bandgap reference ground (QGND). All of these ground reference pins are isolated within the chip to minimize the effects of high current switching transients. For optimum performance the QGND should be returned to the connector through a quiet channel that does not carry transient switching current. The GND and B0GND-B8GND should be connected to the nearest backplane ground pin with the shortest possible path.

Since many different grounding schemes could be implemented and ESD circuitry exists on the DS38C86A, it is important to note that any voltage between ground pins, QGND, GND or B0GND-B8GND should not exceed $\pm 0.5\text{V}$ including power up/down sequencing.

The DS38C86A is offered in 48-pin PQFP high density package style. The 48-pin PQFP is a 7 x 7 space saving package that requires 50% less PCB space than the 44-pin 10 x 10 PQFP package.

Features

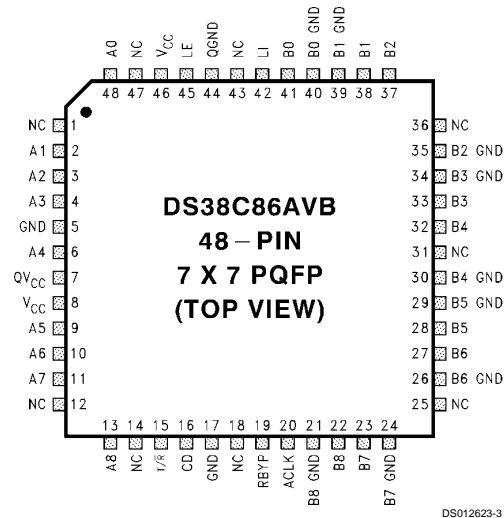
- >50% Less I_{CC} than Bi-CMOS DS3886A
- 9-Bit inverting BTL latching transceiver

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Features (Continued)

- Meets IEEE 1194.1 Standard on Backplane Transceiver Logic (BTL)
- Very low bus-port capacitance—3 pF typical
- Supports live insertion
- Glitch free power-up/down protection
- Fast propagation delays
 - An to Bn (Fall-Thru Mode) 6.0 ns max
 - Bn to An (Bypass Mode) 7.0 ns max
- 1V Signal swings with 80 mA sink capability
- Open drain bus-port outputs allow Wired-OR connection
- Controlled rise and fall time to reduce noise coupling to adjacent lines
- TTL compatible Driver and Control inputs
- Built in Bandgap reference with separate QV_{CC} and QGND pins for precise receiver thresholds
- Individual bus-port ground pins
- Tight skew—
 - Driver 2.0 ns max
 - Receiver 2.5 ns max

Connection Diagram



Ordering Information

NSID	Package	NS Package Number
DS38C86AVB	PQFP (7x7)	VBH48A

Absolute Maximum Ratings (Notes 1 and 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{CC} , Q_{VCC} , LI)	+6.5V
Control Input Voltage	-0.5V to V_{CC} + 0.5V
Driver Input and Receiver Output (An)	-0.5V to V_{CC} + 0.5V
Receiver Input Current	± 15 mA
Bus Voltage (Bn)	+6.5V
Bus Termination Voltage	+2.4V
ESD Bn Pins (HBM)	≥ 2 kV
ESD other Pins (HBM) (Note 12)	≥ 1.5 kV

Power Dissipation at 25°C

PQFP (7x7) (VF48B) 1.56W

Derate PQFP Package 12.5 mW/°C

Storage Temperature Range -65°C to +150°C

Lead Temperature
(Soldering, 4 sec.) 260°C

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	+4.5	+5.0	+5.5	V
Bus Termination Voltage	+2.06	+2.1	+2.14	V
Operating Free Air Temperature	0	+25	+70	°C

DC Electrical Characteristics (Notes 2 and 3)

$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$ unless otherwise noted, $V_{CC} = 5V \pm 10\%$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRIVER AND CONTROL INPUTS (CD, T/R, An, ACLK, LE and RBYP)						
V_{IH}	Minimum Input High Voltage		2.0			V
V_{IL}	Maximum Input Low Voltage				0.8	V
I_{IH}	Input High Current	$V_{IN} = V_{CC}$			40	μA
I_{IL}	Input Low Current	$V_{IN} = 0V$, (except An)			-10	μA
I_{IL}	Input Low Current	$V_{IN} = 0V$, (An)			-100	μA
V_{CL}	Input Diode Clamp Voltage	$I_{CLAMP} = -12$ mA			-1.2	V
DRIVER OUTPUT/RECEIVER INPUT (Bn)						
V_{OLB}	Output Low Bus Voltage (Note 5)	An = T/R = V_{CC} , CD = 0V, $I_{OL} = 80$ mA	0.75	0.9	1.1	V
I_{OFF}	Output Low Bus Current	An = CD = 0V, T/R = V_{CC} , Bn = 0.75V			-200	μA
	Output High Bus Current	An = CD = 0V, T/R = V_{CC} , Bn = 2.1V			300	μA
I_{OLBZ}	Output Low Bus Current	T/R = CD = V_{CC} , Bn = 0.75V (Chip Disabled)			-100	μA
I_{OHBZ}	Output High Bus Current	T/R = CD = V_{CC} , Bn = 2.1V (Chip Disabled)			100	μA
V_{TH}	Receiver Input Threshold	T/R = CD = 0V	1.47	1.55	1.62	V
V_{CLP}	Positive Clamp Voltage	$V_{CC} = \text{Max}$ or 0V, $I_{Bn} = 1$ mA	2.4	3.8	4.5	V
V_{CLN}	Negative Clamp Voltage	$I_{CLAMP} = -12$ mA			-1.2	V
RECEIVER OUTPUT (An)						
V_{OH}	Voltage Output High	Bn = 1.1V, $I_{OH} = -2$ mA, T/R = CD = 0V	2.5	4.8		V
		Bn = 1.1V, $I_{OH} = -100$ μA , T/R = CD = 0V	4.0			V
V_{OL}	Voltage Output Low	Bn = 2.1V, T/R = CD = 0V, $I_{OL} = 24$ mA		0.2	0.5	V
		Bn = 2.1V T/R = CD = 0V, $I_{OL} = 8$ mA		0.1	0.3	V

DC Electrical Characteristics (Notes 2 and 3) (Continued)

$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$ unless otherwise noted, $V_{CC} = 5V \pm 10\%$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RECEIVER OUTPUT (An)						
I_{OZ}	TRI-STATE Leakage Current	$V_{IN} = V_{CC}$, $CD = V_{CC}$, $T/\bar{R} = 0V$, $Bn = 0.75V$			10	μA
		$V_{IN} = 0.0V$, $CD = V_{CC}$, $T/\bar{R} = 0V$, $Bn = 0.75V$			-10	μA
I_{OS}	Output Short Circuit Current	$Bn = 1.1V$, $T/\bar{R} = CD = 0V$ (Note 4)	-40		-120	μA
SUPPLY CURRENT						
I_{CC_DIS}	Standby Current (No Load)	$T/\bar{R} = \text{All An} = V_{CC}$, $CD = V_{CC}$, $ACLK = LE = RBYP = V_{CC}$		15	22	mA
I_{CCT}	Sum of QV_{CC} , V_{CC} , LI	All $Bn = 2.1$, $T/\bar{R} = CD = LE =$ $0.5V$, $ACLK = RBYP = 3.4$		24	31	mA
I_{LI}	Live Insertion Current	$T/\bar{R} = An = CD = RBYP =$ $ACLK = 0.0V$		1	3	mA
		$T/\bar{R} = \text{All An} = RBYP = V_{CC}$, $CD = ACLK = 0V$		1	3	mA

AC Electrical Characteristics (Note 6)

$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = 5V \pm 10\%$

DRIVER (REN = 0V for all conditions)

Symbol	Parameter		Conditions	Min	Typ	Max	Units
DRIVER TIMING REQUIREMENTS							
t _{PHL}	An to Bn, Prop Delay		CD = 0V, T/ \overline{R} = RBYP = 3V	2.0	4.3	6.0	ns
t _{PLH}	Fall-Thru Mode		(Figures 1, 2)	2.0	3.8	6.0	ns
t _{PHL}	ACLK to Bn, Prop. Delay		CD = RBYP = 0V, T/ \overline{R} = 3V	2.0	4.5	6.0	ns
t _{PLH}	Transparent Latch Mode		(Figures 1, 4)	2.0	4.0	6.0	ns
t _{PHL}	CD to Bn	Enable Time	CD = RBYP = 0V, T/ \overline{R} = 3V	3	5.3	7.5	ns
t _{PLH}		Disable Time	(Figures 1, 3)	2.5	4.3	7.5	ns
t _{PHL}	T/ \overline{R} to Bn	Enable Time	CD = 0V, RBYP = 3V	9.0	16.0	22.0	ns
t _{PLH}		Disable Time	(Figures 10, 11)	2.0	6.6	8.0	ns
t _r	Transition Time-Rise/Fall for Bn (20% to 80%)		CD = RBYP = 0V, T/ \overline{R} = 3V	0.8	1.4	3.0	ns
t _f			(Figures 1, 3)(Note 10)	1.0	1.7	3.0	ns
SR	Slew Rate is Calculated from 1.3V to 1.8V for Bn		CD = RBYP = 0V, T/ \overline{R} = 3V (Figures 1, 2)(Note 10)		0.5	0.9	V/ns
t _{SKEW}	ACLK to Bn, Same Package	Output to Output	(Note 7)		0.9	2.5	ns
	An to Bn, Same Package	Output to Output	(Note 7)		0.9	2.0	ns
DRIVER TIMING REQUIREMENTS (Figure 4)							
t _S	An to ACLK (Set-Up Time)		CD = RBYP = 0V, T/ \overline{R} = 3V	3.0			ns
t _H	ACLK to An (Hold Time)			1.0			ns
t _{PW}	ACLK Pulse Width			3.0			ns
RECEIVER							
t _{PHL}	Bn to An, Prop Delay		CD = T/ \overline{R} = 0V, LE = 3V	3.0	4.8	7.0	ns
t _{PLH}	Bypass Mode		(Figures 5, 6)	3.0	5.0	7.0	ns
t _{PHL}	LE to An, Prop Delay		CD = T/ \overline{R} = 0V	4.0	5.7	7.5	ns
t _{PLH}	Latch Mode		(Figures 5, 7)	4.0	5.7	7.5	ns

AC Electrical Characteristics (Note 6) (Continued)

$T_A = 0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$, $V_{CC} = 5\text{V} \pm 10\%$

DRIVER (REN = 0V for all conditions)

Symbol	Parameter		Conditions	Min	Typ	Max	Units
RECEIVER							
t _{PLZ}	CD to An	Disable Time	LE = V _{CC} , Bn = 2.1V, T/ \overline{R} = 0V	3.0	6.3	10.0	ns
t _{PZL}		Enable Time	(Figures 8, 9)	2.5	3.5	10.0	ns
t _{PHZ}		Disable Time	LE = V _{CC} , Bn = 1.1V, T/ \overline{R} = 0V	4.0	7.3	10.0	ns
t _{PZH}		Enable Time	(Figures 8, 9)	3.5	5.5	8.5	ns
t _{PLZ}	T/ \overline{R} to An	Disable Time	LE = V _{CC} , Bn = 2.1V, CD = 0V	3.0	6.0	9.0	ns
t _{PZL}		Enable Time	(Figures 10, 11)	3.0	5.0	9.0	ns
t _{PHZ}		Disable Time	LE = V _{CC} , Bn = 1.1 CD = 0V	3.0	7.3	12.0	ns
t _{PZH}		Enable Time	(Figures 8, 9)	3.0	5.5	12.0	ns
t _{SKEW}	LE to An, Same Package		(Note 7)		0.6	2.5	ns
	Bn to An, Same Package		(Note 7)		0.7	2.5	ns
RECEIVER TIMING REQUIREMENTS (Figure 7)							
t _S	Bn to LE (Set-Up Time)		CD = 0V, T/ \overline{R} = 0V	3			ns
t _H	LE to Bn (Hold Time)			1			ns
t _{PW}	LE Pulse Width			5			ns
PARAMETERS NOT TESTED							
C _{OUTPUT}	Capacitance at Bn		(Note 9)		3		pF
t _{NR}	Noise Rejection		(Note 10)		1		ns

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

Note 2: All input and/or output pins shall not exceed $V_{CC}+0.5\text{V}$ and shall not exceed the absolute maximum rating at any time, including power-up and power-down. This prevents the ESD structure from being damaged due to excessive currents flowing from the input and/or output pins to QV_{CC} and V_{CC} . There is a diode between each input and/or output to V_{CC} which is forward biased when incorrect sequencing is applied. LI and Bn pins do not have power sequencing requirements with respect to V_{CC} and QV_{CC} . Furthermore, the difference between V_{CC} and QV_{CC} should never be greater than 0.5V at any time including power-up.

Note 3: All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified. All typical values are specified under these conditions: $V_{CC} = 5\text{V}$ and $T_A = 25^{\circ}\text{C}$, unless otherwise stated.

Note 4: Only one output should be shorted at a time, and duration of the short should not exceed one second.

Note 5: Referenced to appropriate signal ground. Do not exceed maximum power dissipation of package.

Note 6: Input waveforms shall have a rise and fall time of 3 ns.

Note 7: t_{SKEW} is the absolute value defined as the difference seen in propagation delay between drivers (receivers) in the same package with identical load conditions.

Note 8: This parameter is tested using TDR techniques described in 1194.0 BTL Backplane Design Guide.

Note 9: This parameter is tested during device characterization. The measurements revealed that the part will reject 1 ns pulse width.

Note 10: Futurebus+ transceivers are required to limit bus signal rise and fall times to no faster than 0.5 V/ns, measured between 1.3V to 1.8V (approximately 20% to 80% of the nominal voltage swing). The rise and fall times are measured with a transceiver loading equivalent to 12.5 Ω ties to +2.1 V_{DC} .

Note 11: Capacitance includes jig and probe capacitance.

Note 12: All pins meet 2 kV typical, one device failure observed between An and QV_{CC} in ESD rel sample.

Pin Description

Pin Name	No. of Pins	Input/Output	Description
A0–A8	9	I/O	TTL driver input and TRI-STATE receiver output
ACLK	1	I	Clock input for latch mode
B0–B8	9	I/O	BTL receiver input and driver output
B0 GND–B8 GND	9	NA	Driver output ground reduces ground bounce due to high current switching of driver outputs. (Note 11)
CD	1	I	Chip disable
GND	2	NA	Ground reference for switching circuits (Note 11)
LE	1	I	Latch enable
LI	1	NA	Power supply for live insertion. Boards that require live insertion should connect LI to the live insertion pin on the connector. (Note 12)

Pin Description (Continued)

Pin Name	No. of Pins	Input/Output	Description
NC	9	NA	No connect
QGND	1	NA	Ground reference for receiver input bandgap reference and non-switching circuits (Note 12)
QV _{CC}	1	NA	Power supply for bandgap reference and non-switching circuits (Note 12)
RBYP	1	I	Register bypass enable
T/ \bar{R}	1	I	Transmit/Receive (bar)—transmit (An to Bn), receive (Bn to An)
V _{CC}	2	NA	Power supply for switching circuits (Note 12)

Truth Table

CD	T/ \bar{R}	LE	RBYP	ACLK	An	Bn
H	X	X	X	X	Z	H
L	H	X	H	X	L	H
L	H	X	H	X	H	L
L	H	X	L	X	X	Bn0
L	H	X	L	↑	H	L
L	H	X	L	↑	L	H
L	L	H	X	X	H	L
L	L	H	X	X	L	H
L	L	L	X	X	An0	X

X = High or Low Logic state.

Z = High impedance state.

L = Low state.

H = High state.

↑ = Low to High transition.

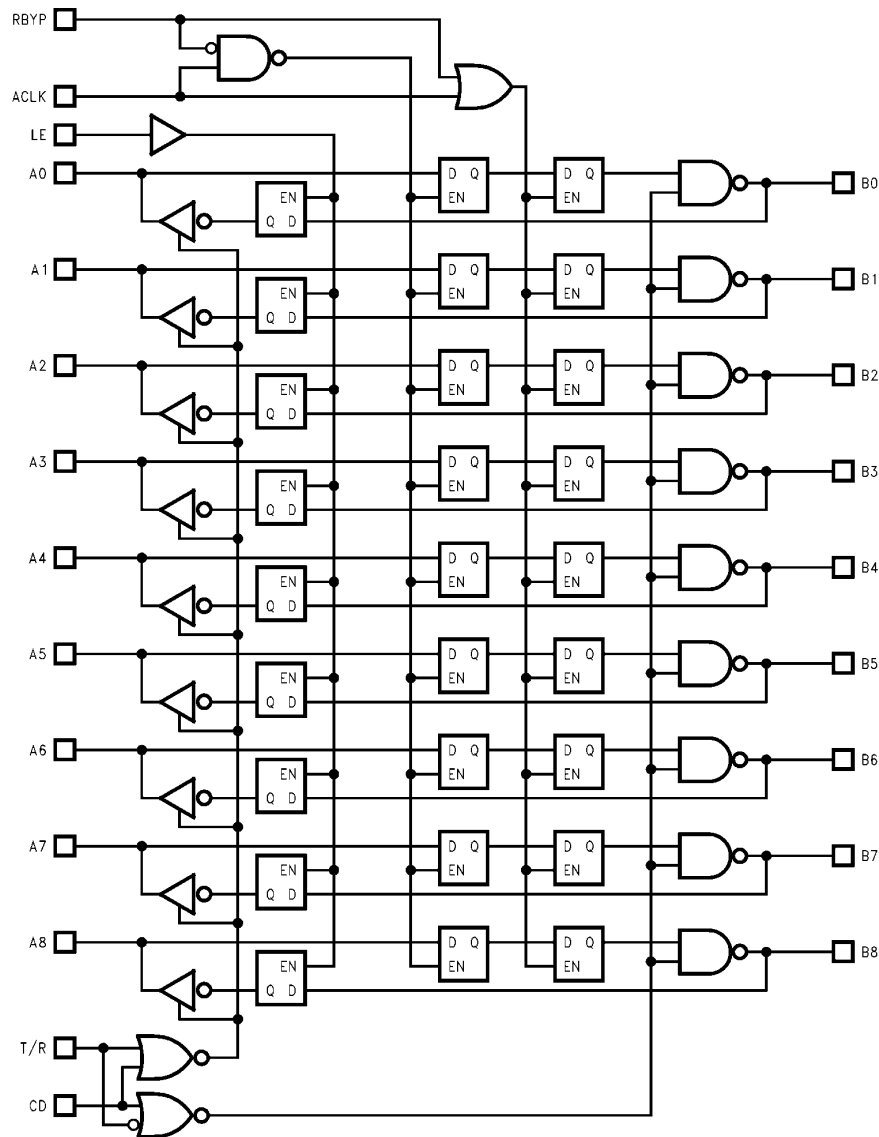
An0 = No change from previous state.

Bn0 = No change from previous state.

BTL = High and Low state are nominally 2.1V and 1.2V, respectively.

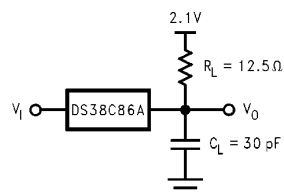
CMOS = High and Low state are nominally V_{CC} and 0V, respectively.

Logic Diagram



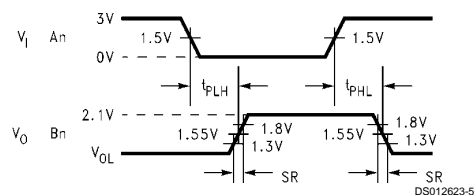
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Test Circuits and Timing Waveforms (Note 11)



DS012623-4

FIGURE 1. Driver Propagation Delay Set-Up



DS012623-5

FIGURE 2. Driver: An to Bn, CD to An

Test Circuits and Timing Waveforms (Note 11) (Continued)

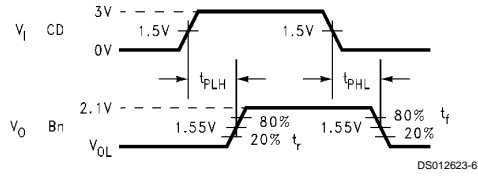


FIGURE 3. Driver: CD to Bn

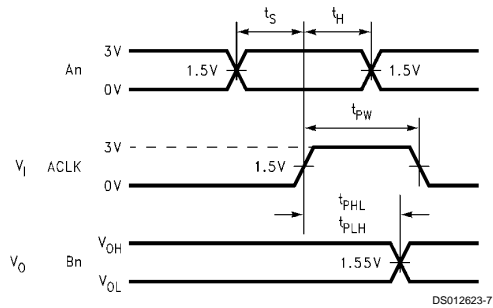


FIGURE 4. Driver: ACLK to Bn, t_S , t_H , t_{PW}

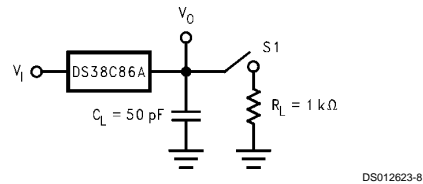


FIGURE 5. Receiver: Propagation Delay Set-Up

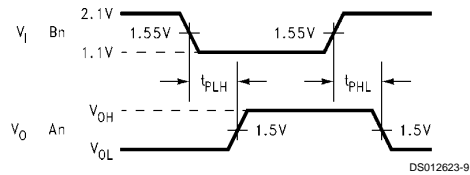


FIGURE 6. Receiver: Bn to An

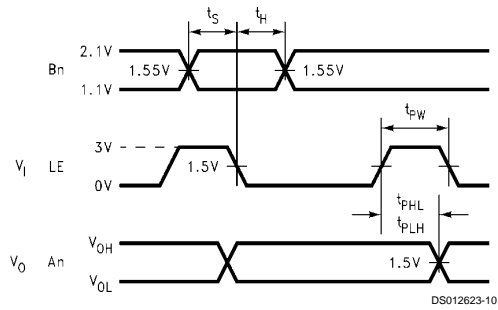


FIGURE 7. Receiver: Enable/Disable Set-Up

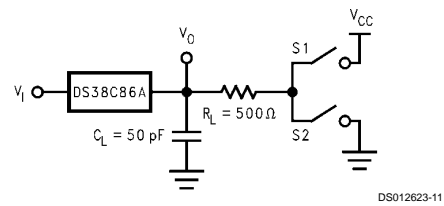


FIGURE 8. Receiver: Enable/Disable Set-Up

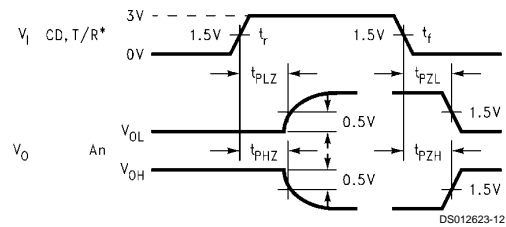


FIGURE 9. Receiver: CD to An, T/R to An (t_{PHZ} and t_{PZH} only)

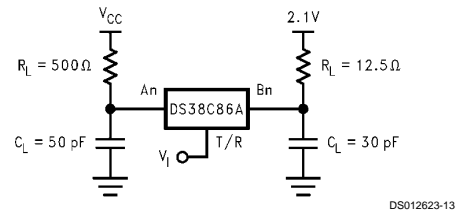
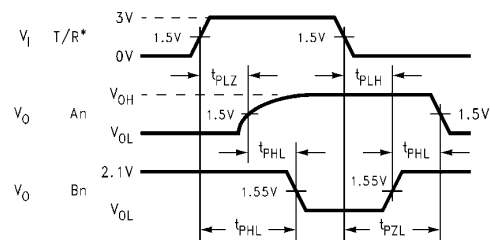


FIGURE 10. T/R to An, T/R to Bn

Test Circuits and Timing Waveforms (Note 11) (Continued)

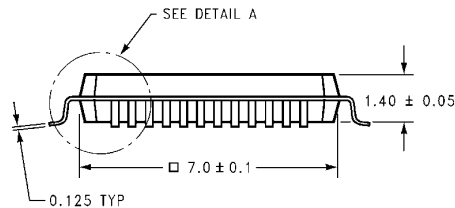
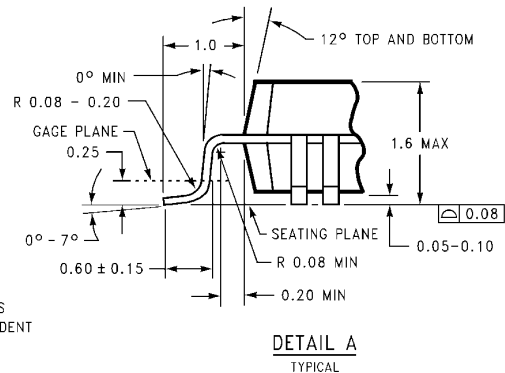
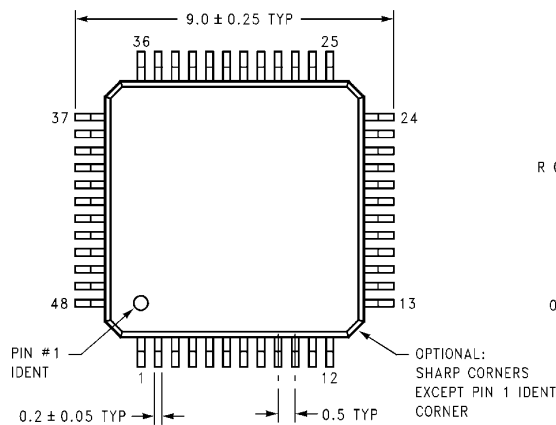


**FIGURE 11. T/R to Bn (t_{PHL} and t_{PLH} only)
T/R to An (t_{PZL} and t_{PLZ} only)**

DS012623-14

Physical Dimensions inches (millimeters)

METRIC ONLY



48-Lead (7mm x 7mm) Molded PQFP, JEDEC
Order Number DS38C86AVB
NS Package Number VBH48A

VBH48A (REV C)

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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