National Semiconductor

June 1998

DS8922/DS8922A/DS8923A TRI-STATE® RS-422 Dual Differential Line Driver and Receiver Pairs

General Description

The DS8922/22A and DS8923A are Dual Differential Line Driver and Receiver pairs. These devices are designed specifically for applications meeting the ST506, ST412 and ESDI Disk Drive Standards. In addition, the devices meet the requirements of the EIA Standard RS-422.

These devices offer an input sensitivity of 200 mV over a ±7V common mode operating range. Hysteresis is incorporated (typically 70 mV) to improve noise margin for slowly changing input waveforms. An input fail-safe circuit is provided such that if the receiver inputs are open the output assumes the logical one state.

The DS8922A and DS8923A drivers are designed to provide unipolar differential drive to twisted pair or parallel wire transmission lines. Complementary outputs are logically ANDed and provide an output skew of 0.5 ns (typ.) with propagation delays of 12 ns.

Both devices feature TRI-STATE outputs. The DS8922/22A have independent control functions common to a driver and receiver pair. The DS8923A has separate driver and receiver control functions.

Power up/down circuitry is featured which will TRI-STATE the outputs and prevent erroneous glitches on the transmission lines during system power up or power down operation.

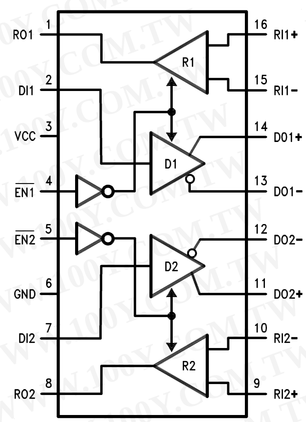
The DS8922/22A and DS8923A are designed to be compatible with TTL and CMOS.

Features

- 12 ns typical propagation delay
- Output skew — ±0.5 ns typical
- Meets the requirements of EIA Standard RS-422
- Complementary Driver Outputs
- High differential or common-mode input voltage ranges of ±7V
- ±0.2V receiver sensitivity over the input voltage range
- Receiver input fail-safe circuitry
- Receiver input hysteresis — 70 mV typical
- Glitch free power up/down
- TRI-STATE outputs

Connection Diagrams

DS8922A Dual-In-Line



Order Number DS8922M, DS8922N, DS8922AM or DS8922AN
See NS Package Number M16A or N16E

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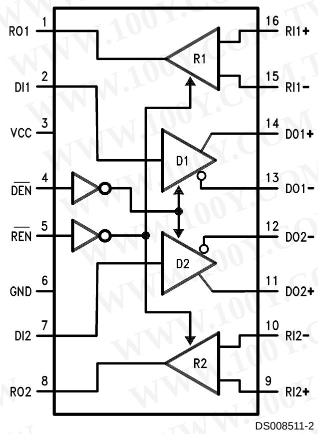
DS8922/DS8922A/DS8923A TRI-STATE RS-422 Dual Differential Line Driver and Receiver Pairs

Connection Diagrams (Continued)

DS8923A Dual-In-Line



Order Number DS8923AM, DS8923AN, See NS Package Number M16A or N16E

Truth Tables

DS8922/22A

$\overline{EN1}$	$\overline{EN2}$	RO1	RO2	DO1	DO2
0	0	ACTIVE	ACTIVE	ACTIVE	ACTIVE
1	0	HI-Z	ACTIVE	HI-Z	ACTIVE
0	1	ACTIVE	HI-Z	ACTIVE	HI-Z
1	1	HI-Z	HI-Z	HI-Z	HI-Z

DS8923A

$\overline{DEN}$	$\overline{REN}$	RO1	RO2	DO1	DO2
0	0	ACTIVE	ACTIVE	ACTIVE	ACTIVE
1	0	ACTIVE	ACTIVE	HI-Z	HI-Z
0	1	HI-Z	HI-Z	ACTIVE	ACTIVE
1	1	HI-Z	HI-Z	HI-Z	HI-Z

Absolute Maximum Ratings (Note 1)

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

Supply Voltage	7V
Drive Input Voltage	−0.5V to +7V
Output Voltage	5.5V
Receiver Output Sink Current	50 mA
Receiver Input Voltage	±10V
Differential Input Voltage	±12V
Maximum Package Power Dissipation @ +25˚C	
M Package	1300 mW
N Package	1450 mW
Derate M Package 10.4 mW/˚C above +25˚C	
Derate N Package 11.6 mW/˚C above +25˚C	
Storage Temperature Range	−65˚C to +165˚C
Lead Temp. (Soldering, 4 seconds)	260˚C

Recommended Operating Conditions

	Min	Max	Units
Supply Voltage	4.5	5.5	V
Temperature (T_A)	0	70	˚C

DS8922/22A and DS8923A Electrical Characteristics (Notes 2, 3, 4)

Symbol	Conditions	Min	Typ	Max	Units
RECEIVER					
V_{TH}	$-7V \le V_{CM} \le +7V$	−200	±35	+200	mV
V_{HYST}	$-7V \le V_{CM} \le +7V$	15	70		mV
R_{IN}	V_{IN} = −7V, +7V (Other Input = GND)	4.0	6.0		kΩ
I_{IN}	V_{IN} = 10V			3.25	mA
	V_{IN} = −10V			−3.25	mA
V_{OH}	V_{CC} = MIN, I_{OH} = − 400 µA	2.5			V
V_{OL}	V_{CC} = MAX, I_{OL} = 8 mA			0.5	V
I_{SC}	V_{CC} = MAX, V_{OUT} = 0V	−15		−100	mA
DRIVER					
V_{OH}	V_{CC} = MIN, I_{OH} = −20 mA	2.5			V
V_{OL}	V_{CC} = MIN, I_{OL} = +20 mA			0.5	V
I_{OFF}	V_{CC} = 0V, V_{OUT} = 5.5V			100	µA
$\lvert VT \rvert - \lvert \overline{VT} \rvert$				0.4	V
VT		2.0			V
$\lvert V_{OS} - \overline{V_{OS}} \rvert$				0.4	V
I_{SC}	V_{CC} = MAX, V_{OUT} = 0V	−30		−150	mA
DRIVER and RECEIVER					
I_{OZ} TRI-STATE Leakage	V_{CC} = MAX, V_{OUT} = 2.5V			50	µA
	V_{CC} = MAX, V_{OUT} = 0.4V			−50	µA
I_{CC}	V_{CC} = MAX, ACTIVE			76	mA
	V_{CC} = MAX, TRI-STATE			78	mA
DRIVER and ENABLE INPUTS					
V_{IH}		2.0			V
V_{IL}				0.8	V
I_{IL}	V_{CC} = MAX, V_{IN} = 0.4V		−40	−200	µA
I_{IH}	V_{CC} = MAX, V_{IN} = 2.7V			20	µA
I_I	V_{CC} = MAX, V_{IN} = 7.0V			100	µA
V_{CL}	V_{CC} = MIN, I_{IN} = −18 mA			−1.5	V

Receiver Switching Characteristics

(*Figures 1, 2, 3*)

Parameter	Conditions	Min	Typ	Max		Units
				8922	8922A/23A	
T_{pLH}	CL = 30 pF		12	22.5	20	ns
T_{pHL}	CL = 30 pF		12	22.5	20	ns
$\|T_{pLH}-T_{pHL}\|$	CL = 30 pF		0.5	5	3.5	ns
Skew (Channel to Channel)	CL = 30 pF		0.5	3.0	2.0	ns
T_{pLZ}	CL = 15 pF S2 Open		15			ns
T_{pHZ}	CL = 15 pF S1 Open		15			ns
T_{pZL}	CL = 30 pF S2 Open		20			ns
T_{pZH}	CL = 30 pF S1 Open		20			ns

Driver Switching Characteristics

Parameter	Conditions	Min	Typ	Max		Units
				8922	8922A/23A	
SINGLE ENDED CHARACTERISTICS (*Figures 4, 5, 6, 8*)						
T_{pLH}	CL = 30 pF		12	15	15	ns
T_{pHL}	CL = 30 pF		12	15	15	ns
T_{TLH}	CL = 30 pF		5	10	10	ns
T_{THL}	CL = 30 pF		5	10	10	ns
$\|T_{pLH}-T_{pHL}\|$	CL = 30 pF		0.5			ns
Skew	CL = 30 pF (Note 5)		0.5	5	3.5	ns
Skew (Channel to Channel)			0.5	3.0	2.0	ns
T_{pLZ}	CL = 30 pF		15			ns
T_{pHZ}	CL = 30 pF		15			ns
T_{pZL}	CL = 30 pF		20			ns
T_{pZH}	CL = 30 pF		20			ns
DIFFERENTIAL SWITCHING CHARACTERISTICS (Note 6), (*Figure 4*)						
T_{pLH}	CL = 30 pF		12	15	15	ns
T_{pHL}	CL = 30 pF		12	15	15	ns
$\|T_{pLH}-T_{pHL}\|$	CL = 30 pF		0.5	6.0	2.75	ns

Note 1: "Absolute Maximum Ratings" are those values 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 currents into device pins are shown as positive values; all currents out of the device are shown as negative; all voltages are referenced to ground unless otherwise specified. All values shown as max or min are classified on absolute value basis.

Note 3: All typical values are V_{CC} = 5V, T_A = 25˚C.

Note 4: Only one output at a time should be shorted.

Note 5: Difference between complementary outputs at the 50% point.

Note 6: Differential Delays are defined as calculated results from single ended rise and fall time measurements. This approach in establishing AC performance specifications has been taken due to limitations of available Automatic Test Equipment (ATE).

The calculated ATE results assume a linear transition between measurement points and are a result of the following equations:

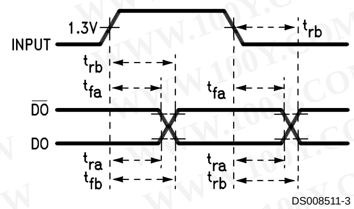
$$Tcp = \frac{(Tfb \times Trb) - (Tra \times Tfa)}{Trb - Tra - Tfa + Tfb}$$

Where:

Tcp = Crossing Point

Tra, Trb, Tfa and Tfb are time measurements with respect to the input.

Switching Time Waveforms



AC Test Circuits and Switching Waveforms

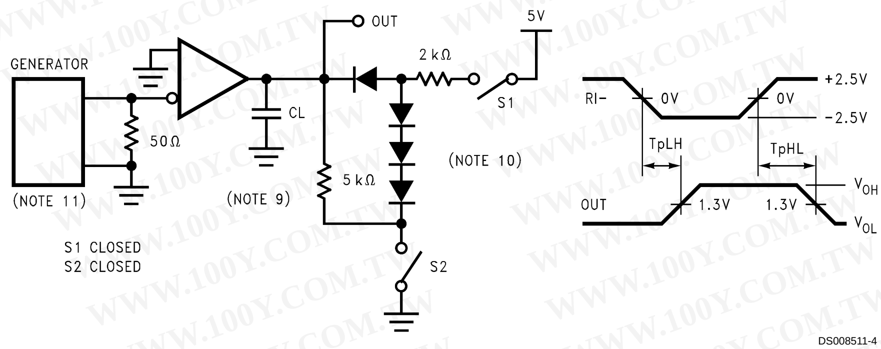


FIGURE 1.

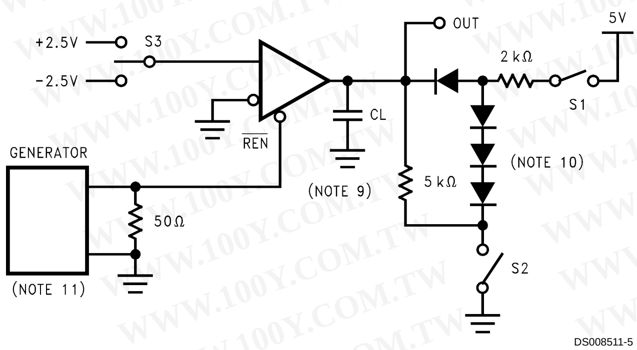
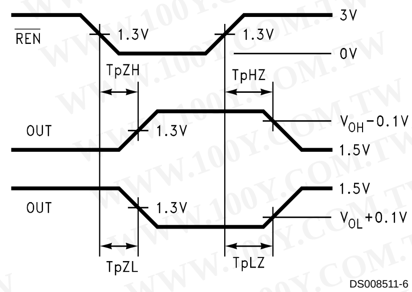


FIGURE 2.

AC Test Circuits and Switching Waveforms (Continued)



	S1	S2	S3
T_{PLZ}	Closed	Open	+2.5V
T_{PHZ}	Open	Closed	−2.5V
T_{PZL}	Closed	Open	+2.5V
T_{PZH}	Open	Closed	−2.5V

FIGURE 3.

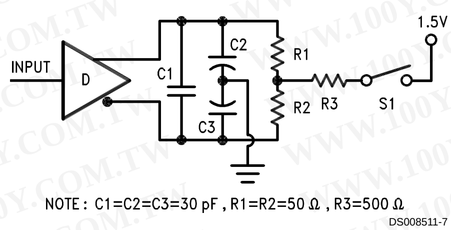


FIGURE 4.

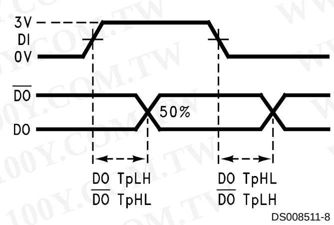


FIGURE 5.

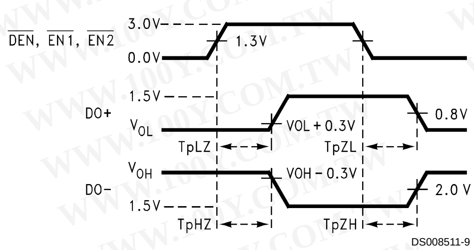


FIGURE 6.

AC Test Circuits and Switching Waveforms (Continued)

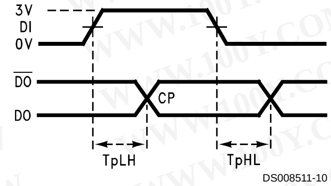


FIGURE 7.

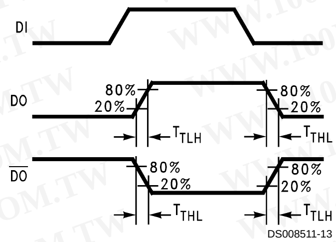
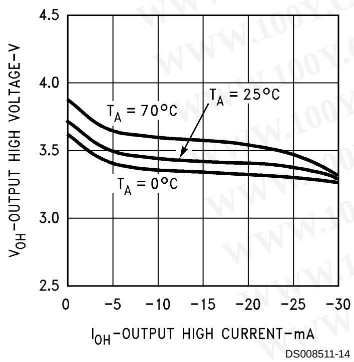


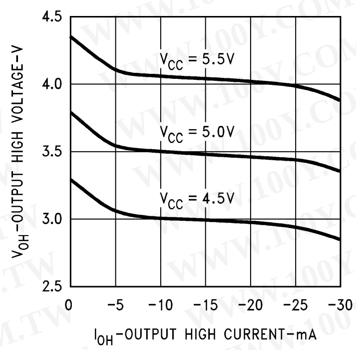
FIGURE 8.

Typical Performance Characteristics (DS8923A)

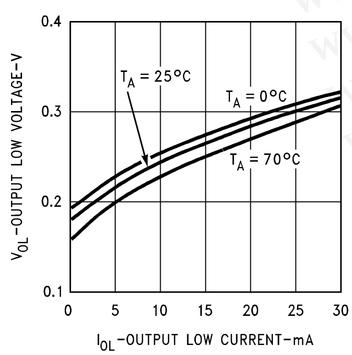
Driver V_{OH} vs I_{OH} vs Temperature



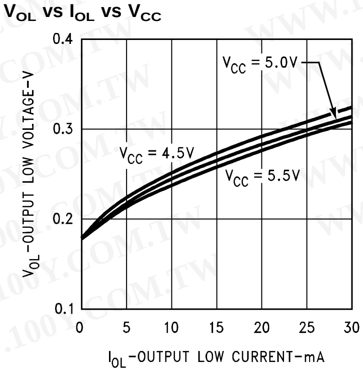
Driver V_{OH} vs I_{OH} vs V_{CC}



Driver V_{OL} vs I_{OL} vs Temperature

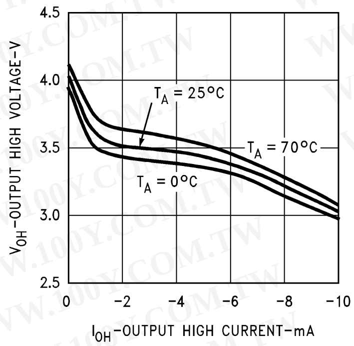


Driver V_{OL} vs I_{OL} vs V_{CC}



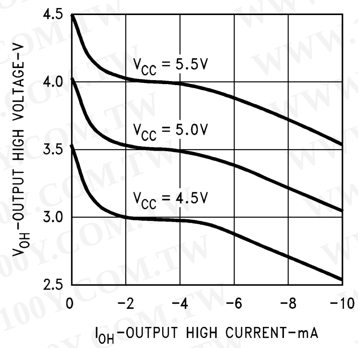
Typical Performance Characteristics (DS8923A) (Continued)

Receiver V_{OH} vs I_{OH} vs Temperature



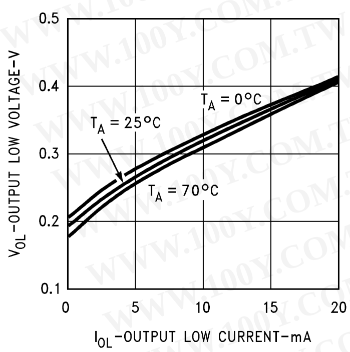
DS008511-18

Receiver V_{OH} vs I_{OH} vs V_{CC}



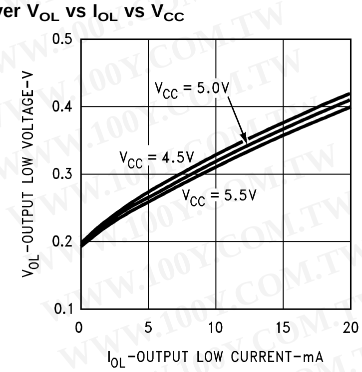
DS008511-19

Receiver V_{OL} vs I_{OL} vs Temperature



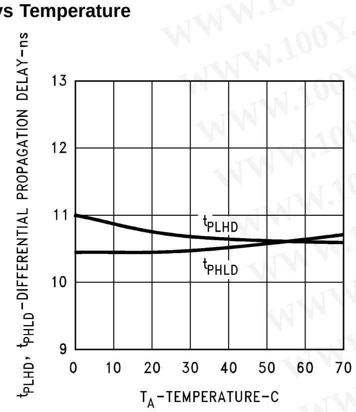
DS008511-20

Receiver V_{OL} vs I_{OL} vs V_{CC}



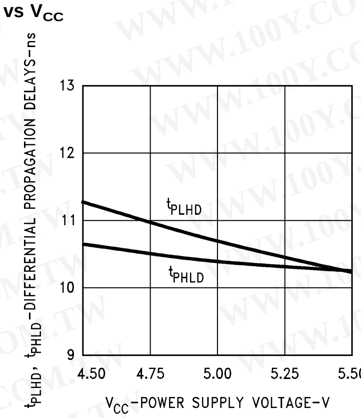
DS008511-21

Driver Differential Propagation Delay vs Temperature



DS008511-22

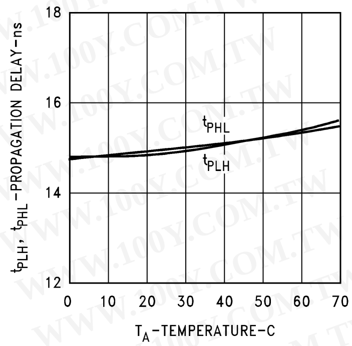
Driver Differential Propagation Delay vs V_{CC}



DS008511-23

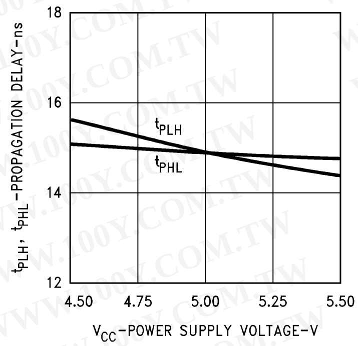
Typical Performance Characteristics (DS8923A) (Continued)

Receiver Propagation Delay vs Temperature



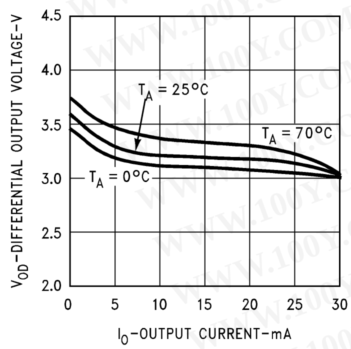
DS008511-24

Receiver Propagation Delay vs V_{CC}



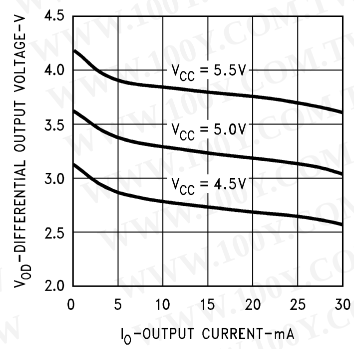
DS008511-25

Driver V_{OD} vs Temperature



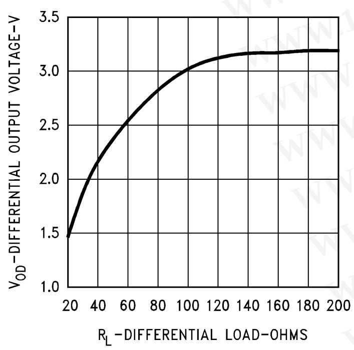
DS008511-26

Driver V_{OD} vs V_{CC}



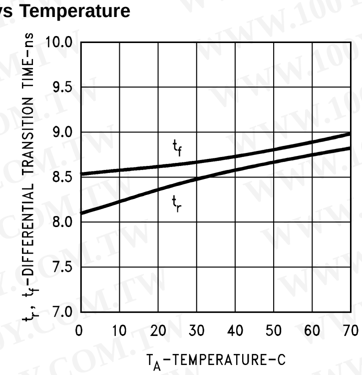
DS008511-27

Driver V_{OD} vs R_L



DS008511-28

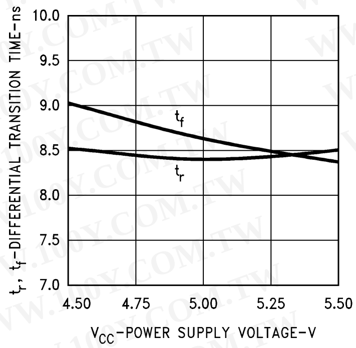
Driver Differential Transition Time vs Temperature



DS008511-29

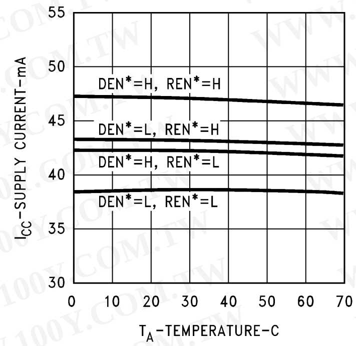
Typical Performance Characteristics (DS8923A) (Continued)

Driver Differential Transition Time vs V_{CC}



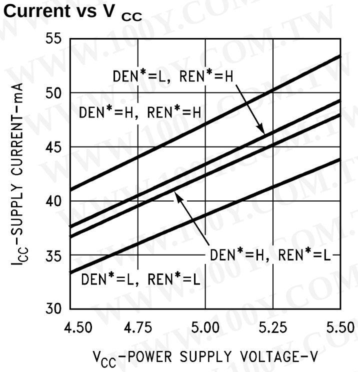
DS008511-30

Supply Current vs Temperature



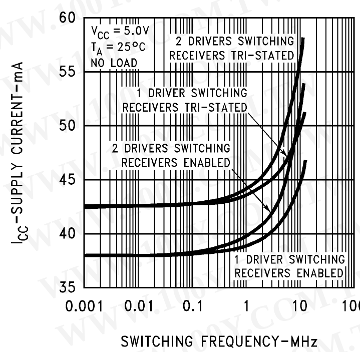
DS008511-31

Supply Current vs V_{CC}



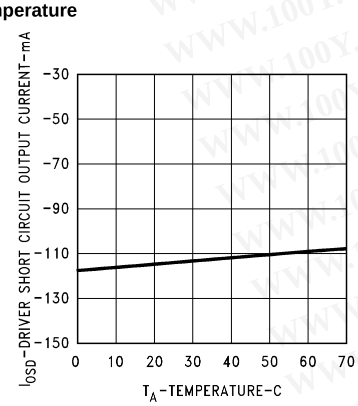
DS008511-32

I_{CC} vs Driver Switching Frequency



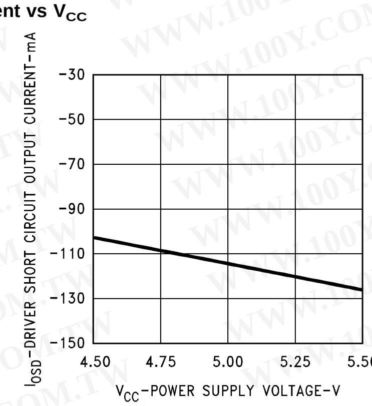
DS008511-33

Driver Short Circuit Current vs Temperature



DS008511-34

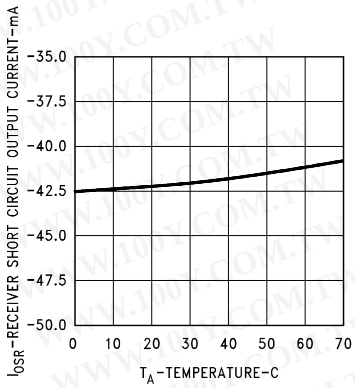
Driver Short Circuit Current vs V_{CC}



DS008511-35

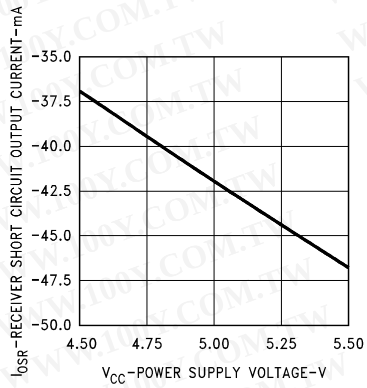
Typical Performance Characteristics (DS8923A) (Continued)

Receiver Short Circuit Current vs Temperature



DS008511-36

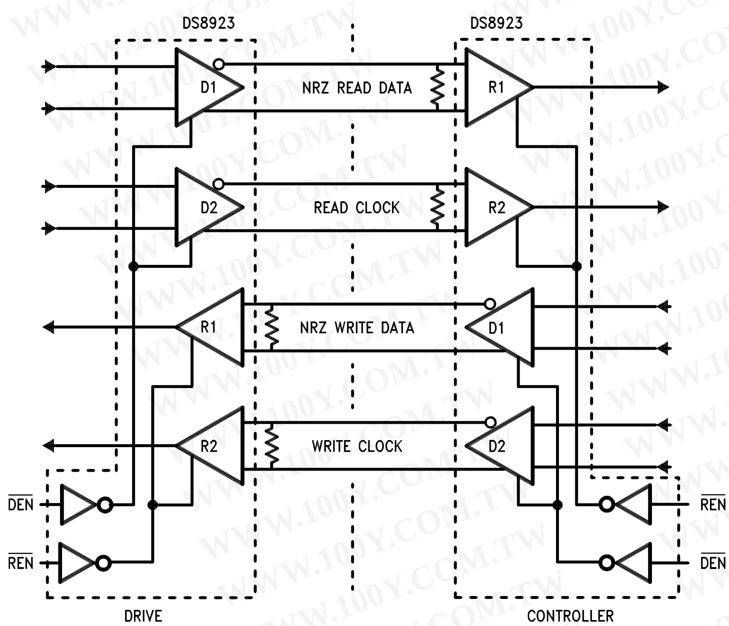
Receiver Short Circuit Current vs V_{CC}



DS008511-37

Typical Applications

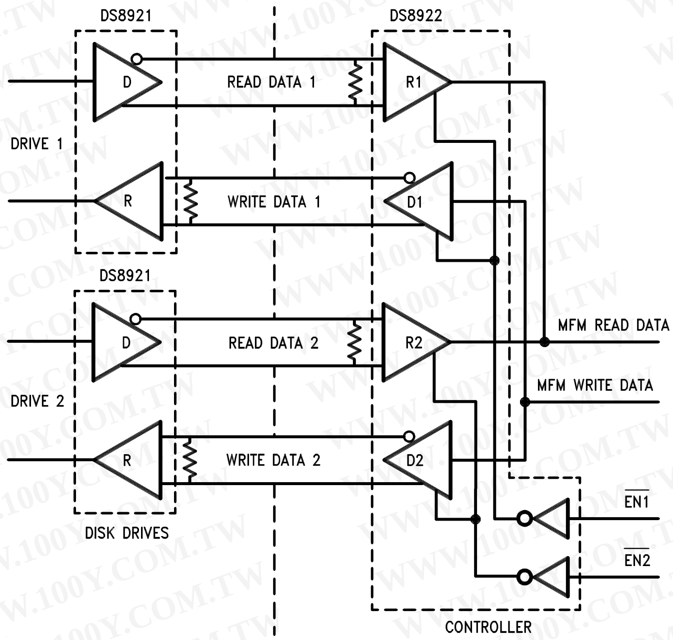
ESDI Application



DS008511-11

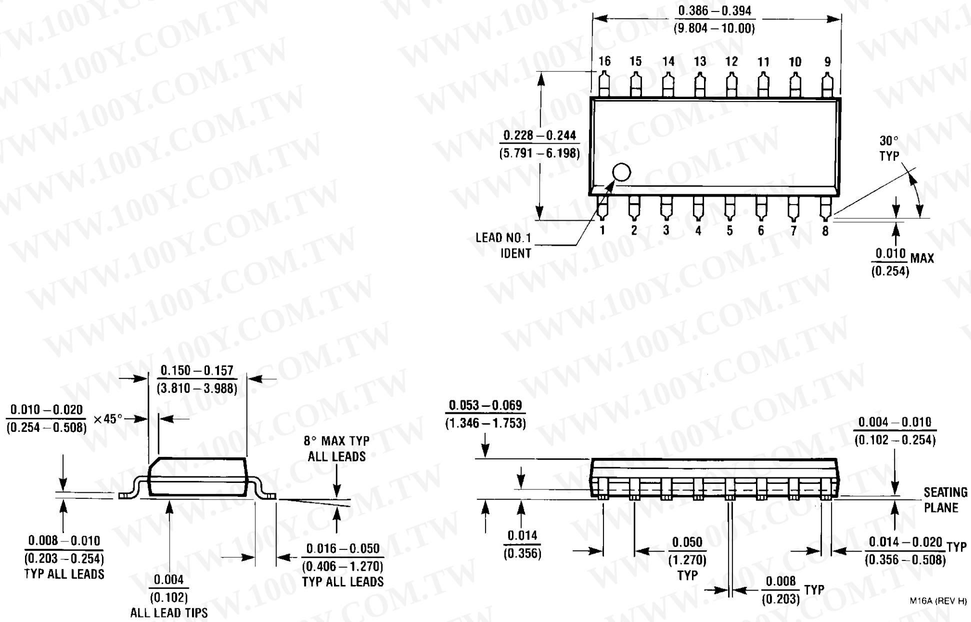
Typical Applications (Continued)

ST504 and ST412 Applications

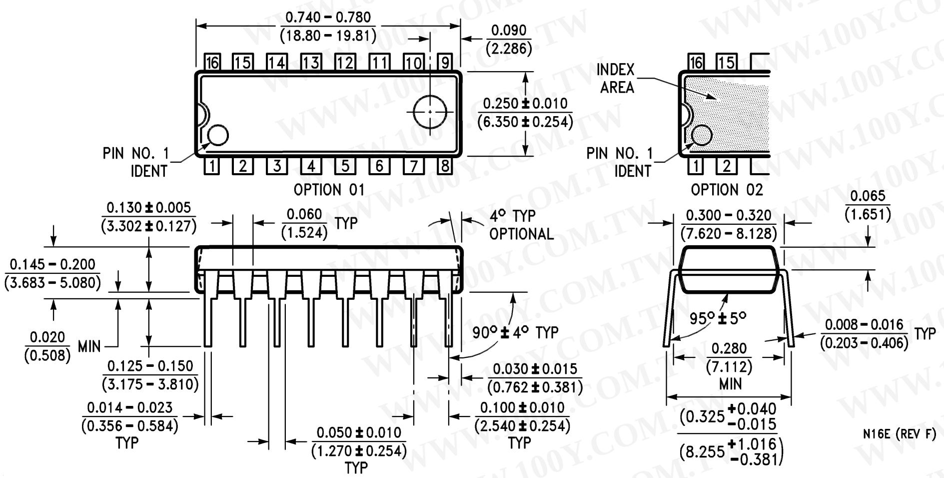


DS008511-12

Physical Dimensions inches (millimeters) unless otherwise noted



SO Package (M)
Order Number DS8922M, DS8922AM, or DS8923AM
NS Package Number M16A



Molded Dual-In-Line Package (N)
Order Number DS8922N, DS8922AN, or DS8923AN
NS Package Number N16E

DS8922/DS8922A/DS8923A TRI-STATE RS-422 Dual Differential Line Driver and Receiver Pairs

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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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