

National Semiconductor is now part of
Texas Instruments.

Search <http://www.ti.com/> for the latest technical
information and details on our current products and services.

DS10CP152Q

Automotive 1.5 Gbps 2X2 LVDS Crosspoint Switch

General Description

The DS10CP152Q is a 1.5 Gbps 2x2 LVDS crosspoint switch optimized for high-speed signal routing and switching over lossy FR-4 printed circuit board backplanes and balanced cables. Fully differential signal paths ensure exceptional signal integrity and noise immunity. The non-blocking architecture allows connections of any input to any output or outputs.

Wide input common mode range allows the switch to accept signals with LVDS, CML and LVPECL levels; the output levels are LVDS. A very small package footprint requires a minimal space on the board while the flow-through pinout allows easy board layout. Each differential input and output is internally terminated with a 100Ω resistor to lower device return losses, reduce component count and further minimize board space.

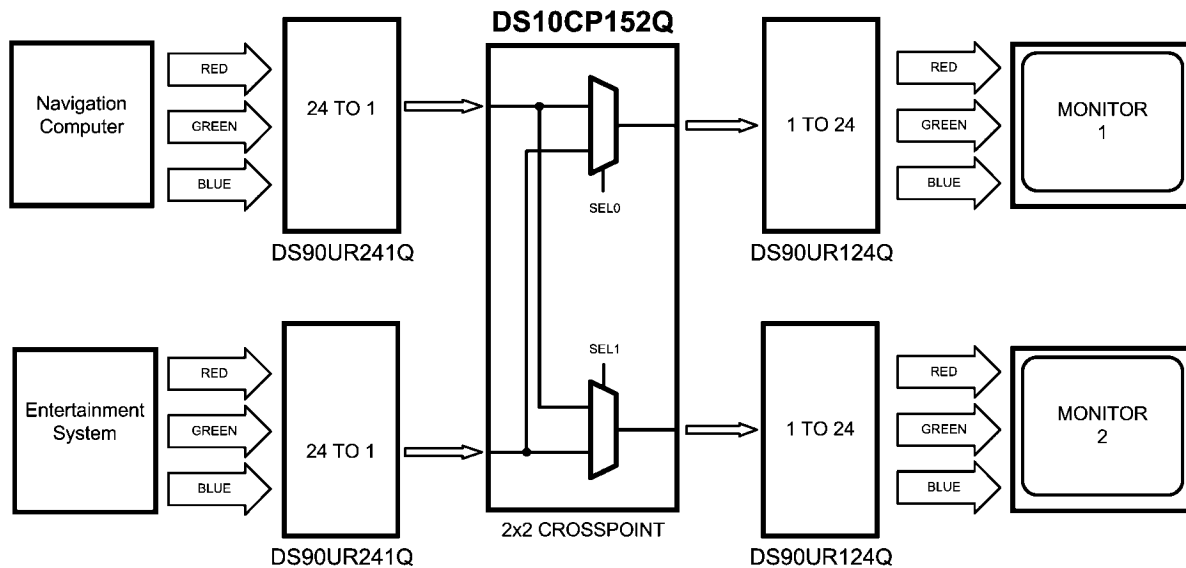
Features

- AECQ-100 Grade 3
- DC - 1.5 Gbps low jitter, low skew, low power operation
- Pin configurable, fully differential, non-blocking architecture
- Wide Input Common Mode Voltage Range allows DC-coupled interface to LVDS, CML and LVPECL drivers
- On-chip 100Ω input and output termination minimizes insertion and return losses, reduces component count and minimizes board space
- 8 kV ESD on LVDS I/O pins protects adjoining components
- Small SOIC-16 space saving package

Applications

- Automotive display applications
- Clock and data buffering and muxing
- SD/HD SDI Routers

Typical Application

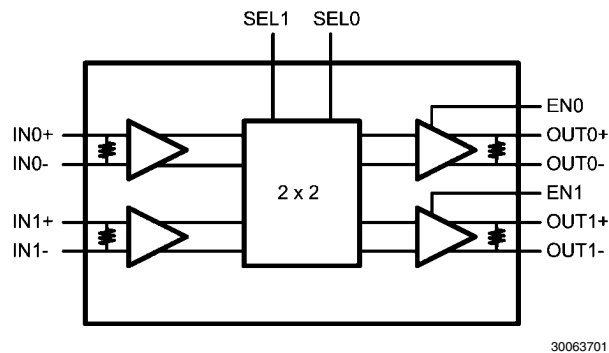


30063770

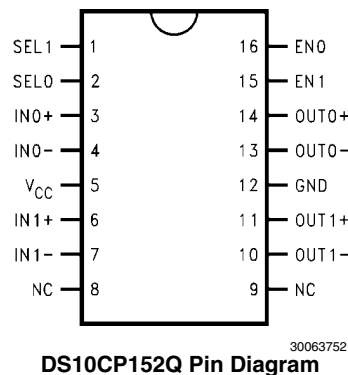
Ordering Code

NSID	Function
DS10CP152QMA	2x2 Crosspoint Switch

Block Diagram



Connection Diagram



DS10CP152Q Pin Diagram

Pin Descriptions

Pin Name	Pin Number	I/O, Type	Pin Description
IN0+, IN0- , IN1+, IN1-	3, 4, 6, 7	I, LVDS	Inverting and non-inverting high speed LVDS input pins.
OUT0+, OUT0- , OUT1+, OUT1-	14, 13, 11, 10	O, LVDS	Inverting and non-inverting high speed LVDS output pins.
SEL1, SEL0	1, 2	I, LVCMOS	Switch configuration pins.
EN0, EN1	16, 15	I, LVCMOS	Output enable pins.
NC	8, 9	NC	"NO CONNECT" pins.
VDD	5	Power	Power supply pin.
GND	12	Power	Ground pin.

Absolute Maximum Ratings (Note 4)

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

Supply Voltage	-0.3V to +4V
LVC MOS Input Voltage	-0.3V to ($V_{CC} + 0.3V$)
LVDS Input Voltage	-0.3V to +4V
LVDS Differential Input Voltage	0V to 1V
LVDS Output Voltage	-0.3V to ($V_{CC} + 0.3V$)
LVDS Differential Output Voltage	0V to 1V
LVDS Output Short Circuit Current Duration	5 ms
Junction Temperature	+105°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature Range	
Soldering (4 sec.)	+260°C
Maximum Package Power Dissipation at 25°C	
M16A Package	1.10W
Derate M16A Package	13.75 mW/°C above +25°C

Package Thermal Resistance

θ_{JA} +72.7°C/W

θ_{JC} +41.2°C/W

ESD Susceptibility

HBM (Note 1) ≥ 8 kV

MM (Note 2) $\geq 250V$

CDM (Note 3) $\geq 1250V$

Note 1: Human Body Model, applicable std. JESD22-A114C

Note 2: Machine Model, applicable std. JESD22-A115-A

Note 3: Field Induced Charge Device Model, applicable std. JESD22-C101-C

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	3.0	3.3	3.6	V
Receiver Differential Input Voltage (V_{ID})	0		1	V
Operating Free Air Temperature (T_A)	-40	+25	+85	°C

DC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Notes 5, 6, 7)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVCMOS DC SPECIFICATIONS						
V_{IH}	High Level Input Voltage		2.0		V_{DD}	V
V_{IL}	Low Level Input Voltage		GND		0.8	V
I_{IH}	High Level Input Current	$V_{IN} = 3.6V$ $V_{CC} = 3.6V$	40	175	250	μA
I_{IL}	Low Level Input Current	$V_{IN} = GND$ $V_{CC} = 3.6V$		± 1	± 10	μA
V_{CL}	Input Clamp Voltage	$I_{CL} = -18$ mA, $V_{CC} = 0V$		-0.9	-1.5	V
LVDS INPUT DC SPECIFICATIONS						
V_{ID}	Input Differential Voltage		0		1	V
V_{TH}	Differential Input High Threshold	$V_{CM} = +0.05V$ or $V_{CC} - 0.05V$		0	+100	mV
V_{TL}	Differential Input Low Threshold		-100	0		mV
V_{CMR}	Common Mode Voltage Range	$V_{ID} = 100$ mV	0.05		$V_{CC} - 0.05$	V
I_{IN}	Input Current	$V_{IN} = 3.6V$ or $0V$ $V_{CC} = 3.6V$ or $0V$		± 1	± 10	μA
C_{IN}	Input Capacitance	Any LVDS Input Pin to GND		1.7		pF
R_{IN}	Input Termination Resistor	Between IN+ and IN-		100		Ω

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVDS OUTPUT DC SPECIFICATIONS						
V_{OD}	Differential Output Voltage	$R_L = 100\Omega$	250	350	450	mV
ΔV_{OD}	Change in Magnitude of V_{OD} for Complimentary Output States		-35		35	mV
V_{OS}	Offset Voltage	$R_L = 100\Omega$	1.05	1.2	1.375	V
ΔV_{OS}	Change in Magnitude of V_{OS} for Complimentary Output States		-35		35	mV
I_{OS}	Output Short Circuit Current (Note 8)	OUT to GND		-23	-55	mA
		OUT to V_{CC}		8	55	mA
C_{OUT}	Output Capacitance	Any LVDS Output Pin to GND		1.2		pF
R_{OUT}	Output Termination Resistor	Between OUT+ and OUT-		100		Ω
SUPPLY CURRENT						
I_{CC}	Supply Current	EN0 = EN1 = H		58	70	mA
I_{CCZ}	Outputs Powered Down Supply Current	EN0 = EN1 = L		25	30	mA

Note 4: "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional and the device should not be operated beyond such conditions.

Note 5: The Electrical Characteristics tables list guaranteed specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.

Note 6: Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except V_{OD} and ΔV_{OD} .

Note 7: Typical values represent most likely parametric norms for $V_{CC} = +3.3V$ and $T_A = +25^\circ C$, and at the Recommended Operation Conditions at the time of product characterization and are not guaranteed.

Note 8: Output short circuit current (I_{OS}) is specified as magnitude only, minus sign indicates direction only.

AC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. (Notes 9, 10, 11)

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
LVDS OUTPUT AC SPECIFICATIONS							
t _{PLHD}	Differential Propagation Delay Low to High	R _L = 100Ω		440	650	ps	
t _{PHLD}	Differential Propagation Delay High to Low			400	650	ps	
t _{SKD1}	Pulse Skew t _{PLHD} – t _{PHLD} (Note 12)			40	120	ps	
t _{SKD2}	Channel to Channel Skew (Note 13)			25	60	ps	
t _{SKD3}	Part to Part Skew (Note 14)			45	190	ps	
t _{LHT}	Rise Time	R _L = 100Ω		170	350	ps	
t _{HLT}	Fall Time			170	350	ps	
t _{ON}	Output Enable Time			5	20	μs	
t _{OFF}	Output Disable Time			3	12	ns	
t _{SEL}	Select Time			3	12	ns	
JITTER PERFORMANCE (Note 11)							
t _{RJ1}	Random Jitter (RMS Value)	V _{ID} = 350 mV V _{CM} = 1.2V Clock (RZ)	135 MHz		0.5	1.2	ps
t _{RJ2}			311 MHz		0.5	1.2	ps
t _{RJ3}			503 MHz		0.5	1.2	ps
t _{RJ4}			750 MHz		0.5	1.2	ps
t _{DJ1}	Deterministic Jitter (Peak-to-Peak Value)	V _{ID} = 350 mV V _{CM} = 1.2V Clock (RZ)	270 Mbps		9	38	ps
t _{DJ2}			622 Mbps		7	36	ps
t _{DJ3}			1.06 Gbps		7	34	ps
t _{DJ4}			1.5 Gbps		9	35	ps
t _{TJ1}	Total Jitter (Peak to Peak Value)	V _{ID} = 350 mV V _{CM} = 1.2V PRBS-23 (NRZ)	270 Mbps		0.01	0.03	UI _{P-P}
t _{TJ2}			622 Mbps		0.01	0.04	UI _{P-P}
t _{TJ3}			1.06 Gbps		0.01	0.05	UI _{P-P}
t _{TJ4}			1.5 Gbps		0.01	0.07	UI _{P-P}

Note 9: The Electrical Characteristics tables list guaranteed specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not guaranteed.

Note 10: Typical values represent most likely parametric norms for $V_{CC} = +3.3\text{V}$ and $T_A = +25^\circ\text{C}$, and at the Recommended Operation Conditions at the time of product characterization and are not guaranteed.

Note 11: Specification is guaranteed by characterization and is not tested in production.

Note 12: t_{SKD1} , $|t_{PLHD} - t_{PHLD}|$, Pulse Skew, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.

Note 13: t_{SKD2} , Channel to Channel Skew, is the difference in propagation delay (t_{PLHD} or t_{PHLD}) among all output channels in Broadcast mode (any one input to all outputs).

Note 14: t_{SKD3} , Part to Part Skew, is defined as the difference between the minimum and maximum differential propagation delays. This specification applies to devices at the same V_{CC} and within 5°C of each other within the operating temperature range.

Note 15: Measured on a clock edge with a histogram and an accumulation of 1500 histogram hits. Input stimulus jitter is subtracted geometrically.

Note 16: Tested with a combination of the 1100000101 (K28.5+ character) and 0011111010 (K28.5- character) patterns. Input stimulus jitter is subtracted algebraically.

Note 17: Measured on an eye diagram with a histogram and an accumulation of 3500 histogram hits. Input stimulus jitter is subtracted.

DC Test Circuits

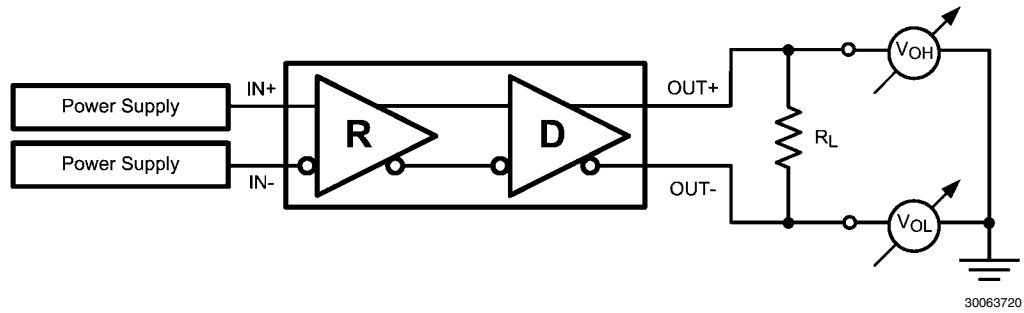


FIGURE 1. Differential Driver DC Test Circuit

AC Test Circuits and Timing Diagrams

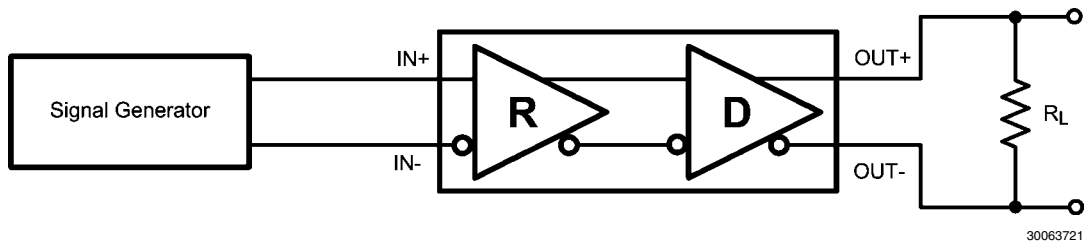


FIGURE 2. Differential Driver AC Test Circuit

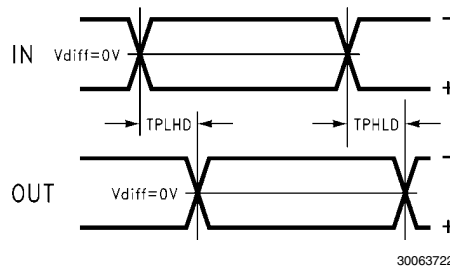


FIGURE 3. Propagation Delay Timing Diagram

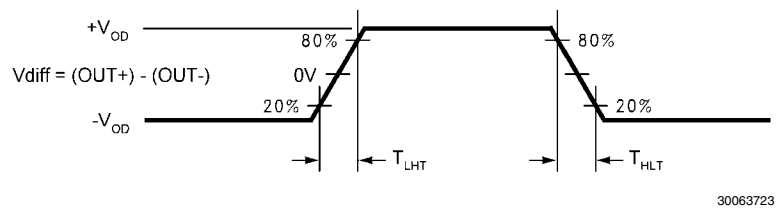


FIGURE 4. LVDS Output Transition Times

Functional Description

The DS10CP152Q is a 1.5 Gbps 2x2 LVDS digital crosspoint switch optimized for high-speed signal routing and switching

over lossy FR-4 printed circuit board backplanes and balanced cables.

TABLE 1. Switch Configuration Truth Table

SEL1	SEL0	OUT1	OUT0
0	0	IN0	IN0
0	1	IN0	IN1
1	0	IN1	IN0
1	1	IN1	IN1

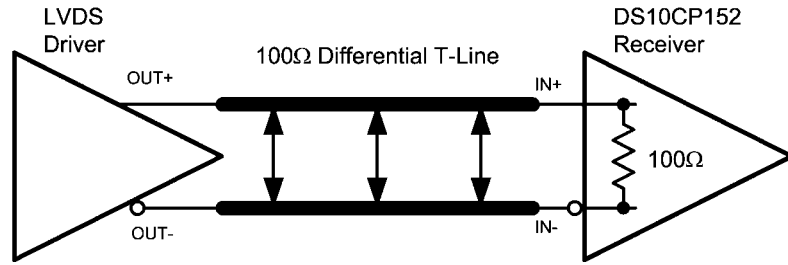
TABLE 2. Output Enable Truth Table

EN1	EN0	OUT1	OUT0
0	0	Disabled	Disabled
0	1	Disabled	Enabled
1	0	Enabled	Disabled
1	1	Enabled	Enabled

INPUT INTERFACING

The DS10CP152Q accepts differential signals and allows simple AC or DC coupling. With a wide common mode range, the DS10CP152Q can be DC-coupled with all common dif-

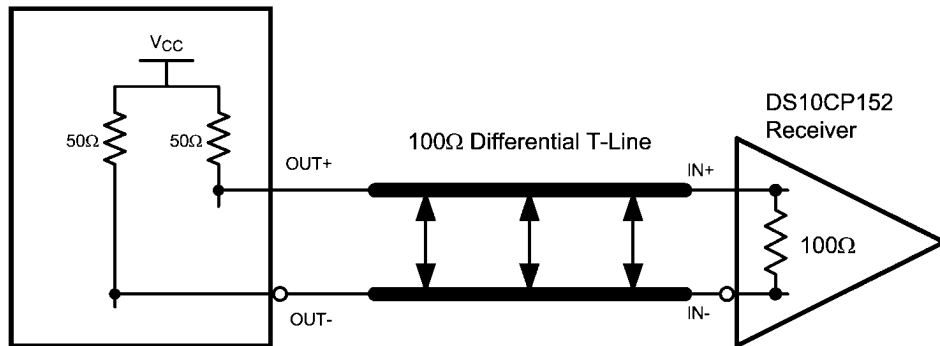
ferential drivers (i.e. LVPECL, LVDS, CML). The following three figures illustrate typical DC-coupled interface to common differential drivers. Note that the DS10CP152Q inputs are internally terminated with a 100Ω resistor.



Typical LVDS Driver DC-Coupled Interface to an DS10CP152Q Input

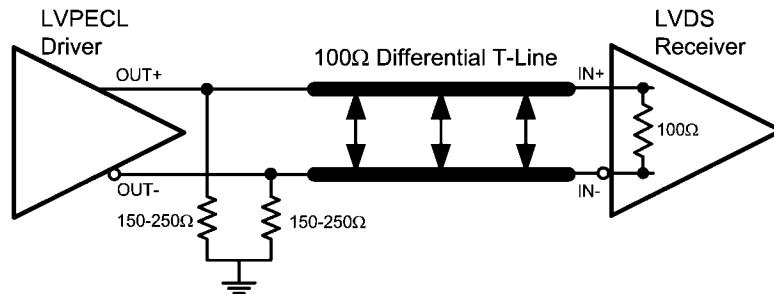
30063731

CML3.3V or CML2.5V
Driver



Typical CML Driver DC-Coupled Interface to an DS10CP152Q Input

30063732



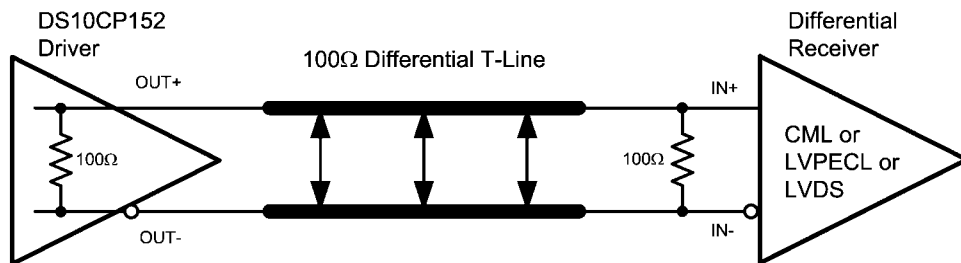
Typical LVPECL Driver DC-Coupled Interface to an DS10CP152Q Input

30063733

OUTPUT INTERFACING

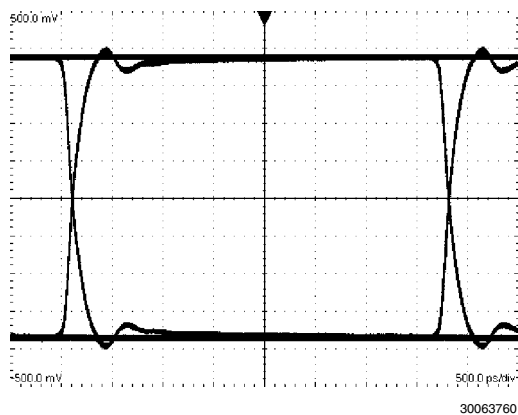
The DS10CP152Q outputs signals compliant to the LVDS standard. Its outputs can be DC-coupled to most common differential receivers. The following figure illustrates typical DC-coupled interface to common differential receivers and

assumes that the receivers have high impedance inputs. While most differential receivers have a common mode input range that can accommodate LVDS compliant signals, it is recommended to check respective receiver's data sheet prior to implementing the suggested interface implementation.

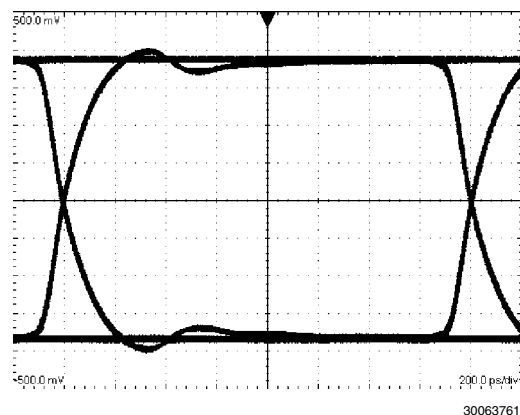


Typical DS10CP152Q Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver 30063734

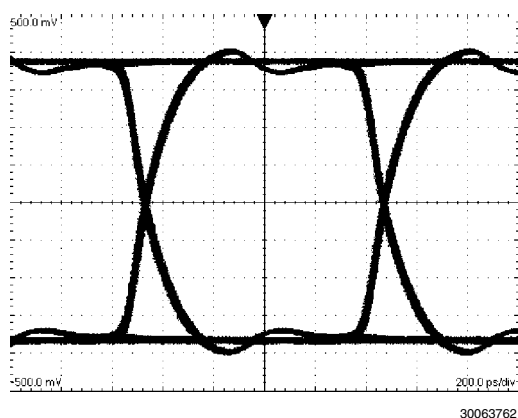
Typical Performance Characteristics



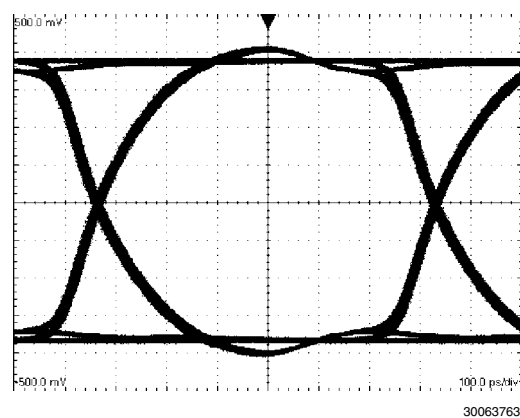
A 270 Mbps NRZ PRBS-7 After 2"
Differential FR-4 Stripline
V:100 mV / DIV, H:500 ps / DIV



A 622 Mbps NRZ PRBS-7 After 2"
Differential FR-4 Stripline
V:100 mV / DIV, H:200 ps / DIV

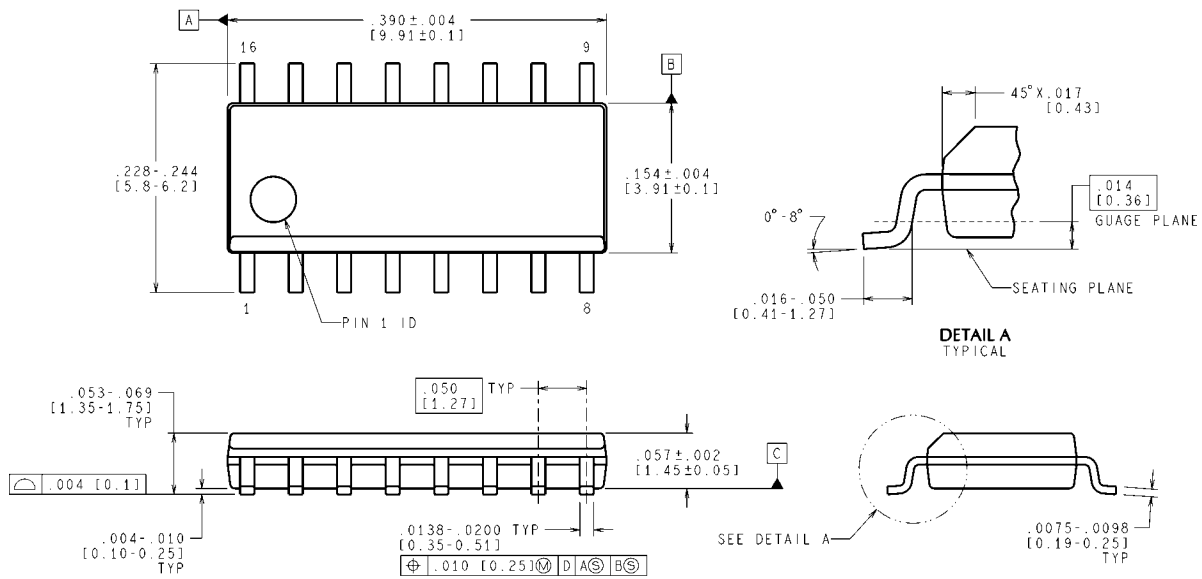


A 1.06 Gbps NRZ PRBS-7 After 2"
Differential FR-4 Stripline
V:100 mV / DIV, H:200 ps / DIV



A 1.5 Gbps NRZ PRBS-7 After 2"
Differential FR-4 Stripline
V:100 mV / DIV, H:100 ps / DIV

Physical Dimensions inches (millimeters) unless otherwise noted



Order Number DS10CP152QMA
NS Package Number M16A

M16A (Rev J)

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH® Tools	www.national.com/webench
Audio	www.national.com/audio	App Notes	www.national.com/appnotes
Clock and Timing	www.national.com/timing	Reference Designs	www.national.com/refdesigns
Data Converters	www.national.com/adc	Samples	www.national.com/samples
Interface	www.national.com/interface	Eval Boards	www.national.com/evalboards
LVDS	www.national.com/lvds	Packaging	www.national.com/packaging
Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage Reference	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Solutions	www.national.com/solutions
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero
Temperature Sensors	www.national.com/tempsensors	SolarMagic™	www.national.com/solarmagic
Wireless (PLL/VCO)	www.national.com/wireless	Analog University®	www.national.com/AU

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in 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.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2009 National Semiconductor Corporation

For the most current product information visit us at www.national.com



**National Semiconductor
Americas Technical
Support Center**
Email: support@nsc.com
Tel: 1-800-272-9959

**National Semiconductor Europe
Technical Support Center**
Email: europe.support@nsc.com

**National Semiconductor Asia
Pacific Technical Support Center**
Email: ap.support@nsc.com

**National Semiconductor Japan
Technical Support Center**
Email: jpn.feedback@nsc.com