HX422D

Honeywell

Radiation Hardened Quad RS422 Differential Line Driver

Features

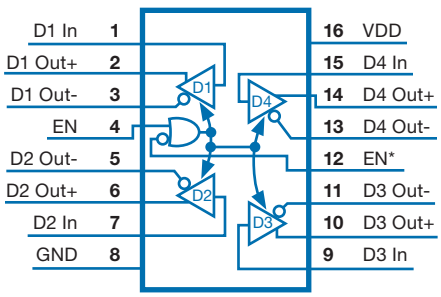
- Four Independent Drivers
- Rad Hard: >300k Rad(Si) Total Dose
- Single +3.3 V Power Supply
- Tristate Outputs
- Common Driver Enable Control
- Minimum Output Differential Voltage: 2V
- Temperature Range: -55°C to +125°C
- Maximum Operating Frequency: 20MHz
- Maximum Propagation Delay: 15ns
- 16 Lead Ceramic Flat Pack

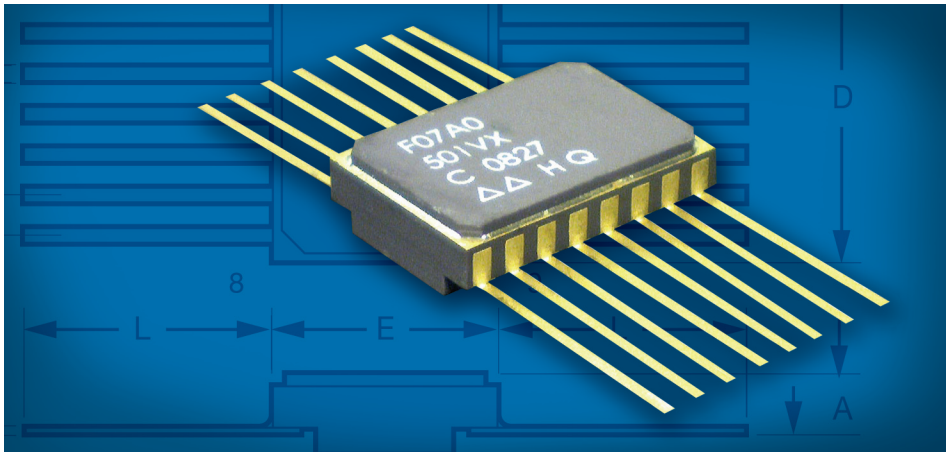
Low Power

The HX422D dissipates less than 1mW in standby mode with no load.

Common Driver Enable Control (EN, EN*)

The EN and EN* inputs allow the user to put the digital outputs into a high impedance state.





The HX422D is a radiation hardened 3.3V CMOS quad differential line driver designed to meet the standard RS422 requirements and digital data transmission over balanced lines.

The HX422D is manufactured SOI-IV Silicon On Insulator (SOI) process with very low power consumption. It features four independent drivers with a common driver enable control and high impedance outputs. The EN and EN* inputs allow active low or active High control of the tristate outputs. The dual enable scheme allows for flexibility in turning devices on or off. The HX422D accepts 3V TTL/CMOS input levels and translates them into differential output voltage signals. The HX422D guarantees a minimum output differential voltage of 2V.

Signal Definition

Signal	Definition
D1 In, D2 In D3 In, D4 In	Single ended CMOS digital data input pins
D1 Out+, D1 Out- D2 Out+, D2 Out- D3 Out+, D3 Out- D4 Out+, D4 Out-	Differential output pins
EN, EN*	Output Enable Control pins. High Impedance: EN = L and EN* = H Normal Operation: All other combinations of EN and EN*

Truth Table

EN	EN*	Data	Q+	Q-
L	H	X	Z	Z
H	X	L	L	H
X	L	L	L	H
H	X	H	H	L
X	L	H	H	L

Absolute Maximum Ratings (1)(2)

Parameter	Symbol	Conditions	Ratings Min	Ratings Max	Units
Supply Voltage	V_{DD}	—	-0.5	+6.5	V
DC Input Voltage	V_{IN}	—	-0.5	V_{DD} + 0.5	V
DC Output Voltage (3)	V_{OUT}	—	-0.5	V_{DD} + 0.5	V
Input Diode Clamp Current	I_{ik}	VI < 0-VTH_diode or VI > VDD + VTH_diode	-180	+180	mA
Output Short Circuit Current (4) (5)	Ios	D1 Out+, D1 Out-, D2 Out+, D2 Out- D3 Out+, D3 Out-, D4 Out+, D4 Out- VOUT = 0.0 V, Enabled EN = H	30	300	mA
DC Output Current, Per Pin	I_{OUT}	VO= 0 to VDD		+70	mA
Thermal Resistance, Junction to Case	θ_{JC}	—	—	+22.5	°C/W
Storage Temperature Range	T_{STG}	—	-65	+150	°C
Lead Temperature Range (soldering, 4 seconds)	T_{LMAX}	—	—	+300	°C
Junction Temperature	T_J	—	—	+175	°C
ESD (HBM)	—	—	2000		V

(1) Stresses above the absolute maximum rating may cause permanent damage to the device. Extended operation at the maximum levels may degrade performance and affect reliability.
(2) Manufacturer does not guarantee the operation of the part in this manner. Temporary operation of input pins above or below the rails during a dose event could (though unlikely) compromise the total dose capability of the part.
(3) RS422 Transmit Buffer must withstand a disabled or un-powered RS422 Receiver for an unlimited period of time, without being damaged.
(4) Output Short Circuit not intended to imply continuous operation.
(5) Transmitter shall withstand without damage the application of short circuit across its output terminals, or from any output to circuit ground for at least 5 minutes. The transmitter should resume normal operation when the short is removed. One output at a time should be shorted and the maximum junction temperature should not be exceeded. It should be tested for a maximum of 1 second.
(6) All unused inputs of the device must be held at VDD or GND to ensure proper device operation.

Recommended Operating Conditions (1)

Parameter	Symbol	Limit Min	Limit Max	Units
Supply Voltage	V_{DD}	3.0	3.6	V
Case Operating Temperature	T_C	-55	+125	°C
High Level Input Voltage	V_{IN}	0.7 x VDD	V_{DD}	V
Low Level Input Voltage	V_{OUT}	0	0.3 x VDD	V
Input Voltage	I_{OUT}	-0.3	VDD + 0.3	V
Output Voltage	V_{OUT}	-0.3	VDD + 0.3	V

(1) All unused inputs of the device must be held at VDD or GND to ensure proper device operation.

Radiation Hardness Ratings (1)(2)

Parameters	Limits	Units	Test Conditions
Total Dose	≥300	krad(Si)	VDD= Maximum
Transient Dose Rate Upset	≥1x10^9	rad(Si)/s	PW = 20ns, 3µs X-ray, VDD = Minimum
Dose Rate Survivability	≥1 x10^{12}	rad(Si)/s	PW = 20ns, 3µs X-ray, VDD = Maximum
Neutron Fluence	≥1 x10^{14}	N/cm^2	1MeV equivalent energy, Unbiased

(1) Ambient temperature 25°C unless otherwise specified.
(2) Device will not latch up due to any of the specified radiation exposure conditions.

Radiation Performance

Total Ionizing Radiation Dose

The device will meet all stated functional and electrical specifications after the specified total ionizing radiation dose. All electrical and timing performance parameters will remain within specifications, post rebound (based on extrapolation), after an operational period of 15 years. Total dose hardness is assured by wafer level testing of process monitor transistors using 10 KeV X-ray. Parameter correlations have been made between 10 KeV X-rays applied at a dose rate of $5x10^5$ rad(SiO_2)/min at T= 25°C and gamma rays (Cobalt 60 source) to ensure that wafer level X-ray testing is consistent with standard military radiation test environments.

Transient Pulse Ionizing Radiation

The HX422D will meet any functional or electrical specification after exposure to a radiation pulse up to the transient dose rate survivability specification, when applied under recommended operating conditions. Note that the current conducted during the pulse by the inputs, outputs, and power supply may significantly exceed the normal operating levels. The application design must accommodate these effects.

Neutron Radiation

The HX422D will meet any functional or timing specification after exposure to the specified neutron fluence under recommended operating or storage conditions.

Latchup and Snapback

The HX422D will not latch up due to any of the above radiation exposure conditions when applied under recommended operating conditions.

Electrical Requirements

Parameter	Symbol	Conditions		Limit Min	Limit Max	Units
Output Differential Voltage	V_{D1}	No Load		—	3.6	V
Output Differential Voltage	V_{D2}	R_L = 100 Ω		2.0	—	V
Output Differential Voltage Change	ΔV_{D2}	I_{OUT} 0 – 20 mA		-0.4	0.4	V
Common Mode Voltage	V_{CM}	R_L = 100 Ω		—	2	V
Common Mode Voltage Change	ΔV_{CM}	R_L = 100 Ω		-0.4	+0.4	V
Tristate Output Leakage High	I_{OZH}	$V_{OUT} = V_{DD}$, disabled		—	20	µA
Tristate Output Leakage Low	I_{OZL}	V_{OUT} = 0.0 V, disabled		-20	—	µA
Output High Voltage	V_{OH}	I_{OUT} = -20 mA		2.0	—	V
Output Low Voltage	V_{OL}	I_{OUT} = 20 mA		—	0.5	V
Input Threshold High	V_{IH}	V_{DD} = 3.6 V, ($V_{IHMIN} = 0.7*V_{DD}$)		2.5	—	V
Input Threshold Low	V_{IL}	V_{DD} = 3.0 V, ($V_{IHMAX} = 0.3*V_{DD}$)		—	0.9	V
Input Leakage Current High	I_{IH}			-10	10	µA
Input Leakage Current Low	I_{IL}			-10	10	µA
Input Clamp Diode Voltage	V_{IKL}	I_{IN} = -20 mA		-1.5	—	V
	V_{IKH}	I_{IN} = 20 mA		—	+1.5V	V
Standby Current	I_{DD}	V_{DD}, No Load, Inputs = 0 V or V_{DD}		—	150	µA
Operational Supply Current	IDDOP1	VDD = 3.6V, CL = 85pF	1MHz		140	mA
	IDDOP10	RL = 100 ohms	10MHz		230	mA
	IDDOP20	All outputs toggling	20MHz		280	mA

Capacitance Parameters

Symbol	Parameter	Limits Min	Limits Max	Units
C_I	Input Capacitance CMOS Inputs	3⁄4	12	pF
C_O	Output Capacitance (pin to ground)		20	pF

Switching Requirements

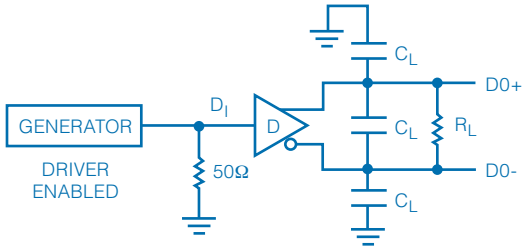
(R_L = 100 ohms, C_L = 50pF)

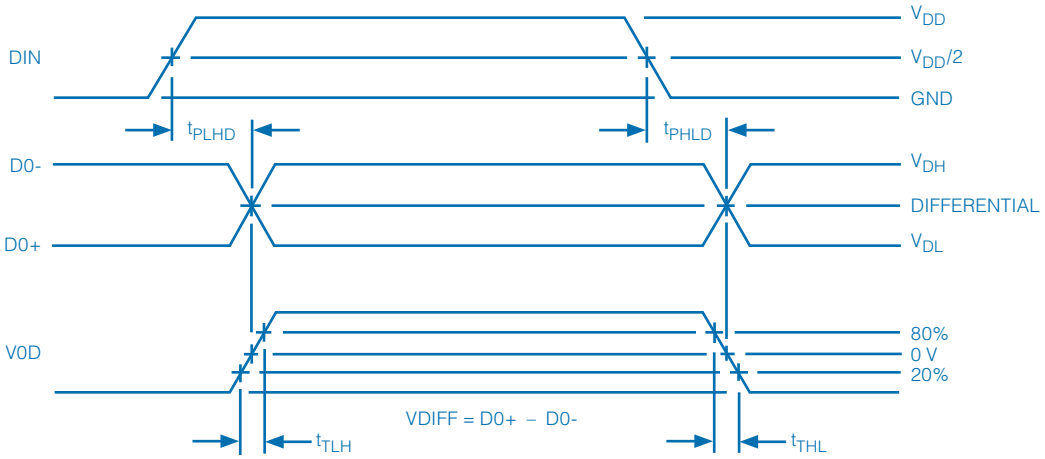
Symbol	Parameter	Limit		Units
		Min	Max	
CI	Input Capacitance CMOS Inputs	3/4	12	pF
CO	Output Capacitance (pin to ground)		20	pF
t_{pwd} (1) (2)	Driver output jitter		650	ps
t_{pwd} (1) (2)	Driver output jitter with power supply noise		800	ps
t_{PHLD}	Differential Propagation Delay High to Low	0.25	15	ns
t_{PLHD}	Differential Propagation Delay Low to High	0.25	15	ns
t_{SKD} (1)	Differential Pulse Skew (same channel) $\lvert t_{PHLD} - t_{PLHD} \rvert$		3	ns
ΔSK_{CC1}(1)	Differential Channel-to-Channel Skew		3	ns
t_{TLH}	Differential Output Transition Time Low to High (20% to 80%)		10	ns
t_{THL}	Differential Output Transition Time High to Low (20% to 80%)		10	ns
t_{PHZ}	Disable Time High to Z		20	ns
t_{PLZ}	Disable Time Low to Z		20	ns
t_{PZH}	Enable Time Z to High	0.25	20	ns
t_{PZL}	Enable Time Z to Low	0.25	20	ns
F_{max}	Max Operating Frequency		20	MHz

(1) Guaranteed but not tested in production.
(2) Maximum RS422 Driver Jitter performance is guaranteed between -5°C and 125°C case temperature, between 3.0 V and 3.6 V; and pre- and post-radiation.
(a) Driver CMOS input signal transition time of 1.0 ns, 10%-to-90% for a 0 V - V_{DD} waveform.
(b) Apply a minimum of 250 Pseudo Random Bit Stream (PRBS) bits, at 25 Mbps rate, with no more than 10 consecutive non-transitioning bits in the data stream, at RS422 driver CMOS input. Refer to Figure 7.
(c) Measure peak-to-peak data jitter at RS422 driver output across the 100 Ω resistor.
(d) All jitter measurements will be made with a sample size of 100,000 and a Bit Error Rate of 1E-12.

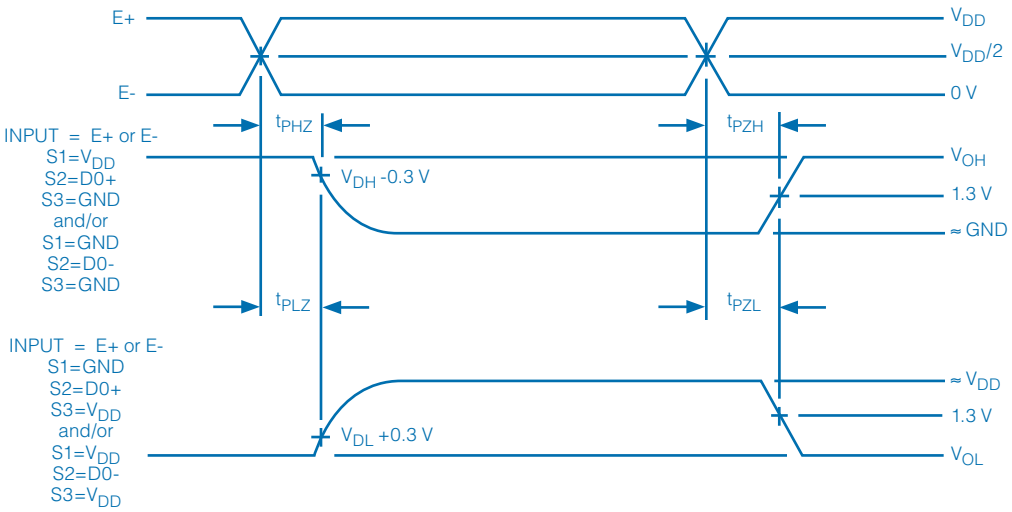
Timing Diagrams

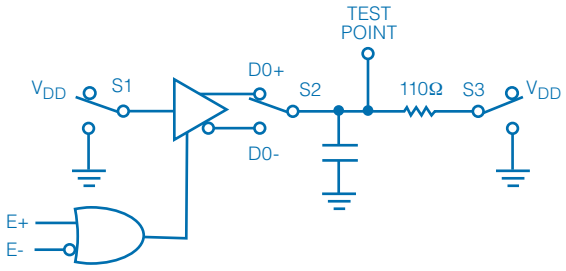
Differential Driver Propagation Delay, Jitter and Transition Time





Differential Driver Single-Ended Three State





ESD (Electrostatic Discharge) Sensitive

The HX422D is ESD rated as Class 2. Proper ESD precautions should be taken to avoid degradation or damage to the device.

Reliability

For many years Honeywell has been producing integrated circuits that meet the stringent reliability requirements of space and defense systems. Honeywell has delivered hundreds of thousands of QML parts since first becoming QML qualified in 1990. Using this proven approach Honeywell will assure the reliability of the products manufactured with the SOI CMOS process technology. This approach includes adhering to Honeywell's General Manufacturing Standards for:

- Designing in reliability by establishing electrical rules based on wear out mechanism characterization performed on specially designed test structures (electromigration, TDDB, hot carriers, negative bias temperature instability, radiation)
- Utilizing a structured and controlled design process
- A statistically controlled wafer fabrication process with a continuous defect reduction process
- Individual wafer lot acceptance through process monitor testing (includes radiation testing)
- The use of characterized and qualified packages
- A thorough product testing program based on MIL-PRF-38535 and MIL-STD 883.

Qualification and Screening

The SOI CMOS technology is qualified by Honeywell after meeting the criteria of the General Manufacturing Standards and is also QML Qualified. This qualification is the culmination of years of development, testing, documentation, and on-going process control.

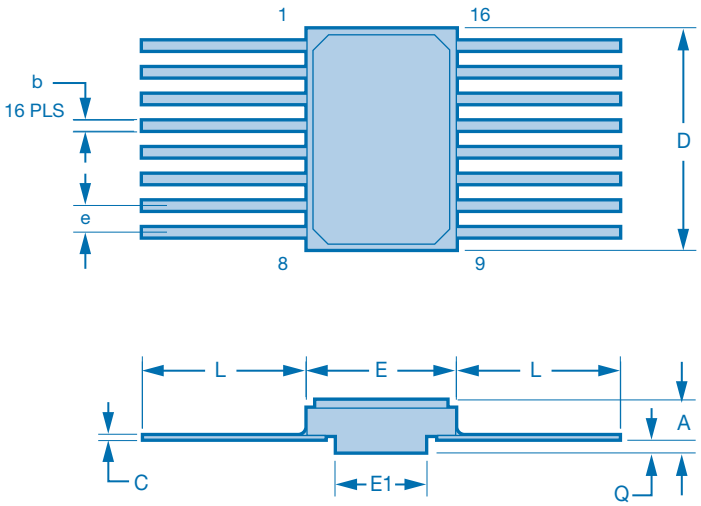
The test flow includes screening units with the defined flow (Class V and Q+) and the appropriate periodic or lot conformance testing (Groups B, C, D, and E). Both the process and the products are subject to period or lot based Technology Conformance Inspection (TCI) and Quality Conformance Inspection (QCI) tests, respectively, as defined by Honeywell's Quality Management Plan.

Honeywell delivers products that are screened to two levels including Engineering Models and Flight Units. EMs are available with limited screening for prototype development and evaluation testing.

Group A	Final Lot Acceptance Electrical Tests
Group B	Mechanical – Dimensions (1), Bond Strength, Solvents, Die Shear, Solderability, Lead Integrity, Seal, Acceleration
Group C	Life Tests – 1000 hours at 125°C or equivalent
Group D	Package related mechanical tests – Shock, Vibration, Accel, Salt (1), Seal, Lead Finish Adhesion, Lid Torque, Thermal Shock, Temp Cycle, Moisture Resistance
Group E	Radiation Tests

(1) Testing performed by package supplier.

Package Outline Dimensions



Symbol	Dimensions - Inches Min	Dimensions - Inches Max	Dimensions - Millimeters Min	Dimensions - Millimeters Max
A	.101	.125	2.57	3.18
b	.015	.019	0.38	0.48
c	.004	.007	0.11	0.18
D	.392	.408	9.96	10.36
e	.047	.053	1.20	1.34
E	.274	.286	6.96	7.26
E1	.185	.196	4.70	4.96
L	.320	.360	8.13	9.14
Q	.022	.032	0.56	0.82

Ordering Information

H	X	422	D	G	V	F

Source
H = Honeywell

Process
X = SOI CMOS

Part Number

Part Type

Package Designation
N = 16 Pin Flat Pack

Screen Level
V = QML V
W = Model (2)
E = Eng. Model (2)

Total Dose Hardness
H = $3x10^5$ rad (Si)
N = No Level Guaranteed (2)

(1) Orders may be faxed to 763-954-2051. Please contact our Customer Service Representative at 1-763-954-2474 for further information.
(2) Engineering Device Description: Parameters are tested -55°C to 125°C, 24 hour burn-in, no radiation guaranteed.
(3) Not applicable.

Standard Microcircuit Drawing

The HX422D can be ordered under the SMD drawing 5962-07A05.

QCI Testing (1)

Classification	QCI Testing
QML Q+	No lot specific testing performed. (2)
QML V	Lot specific testing required in accordance with MIL-PRF-38535 Appendix B.

(1) QCI groups, subgroups and sample sizes are defined in MIL-PRF38535 and the Honeywell QM Plan. Quarterly testing is done in accordance with the Honeywell QM Plan.
(2) If customer requires lot specific testing, the purchase order must indicate specific tests and sample sizes.

Find out more

To learn more about Honeywell's radiation hardened integrated circuit products and technologies, visit www.honeywell.com/microelectronics.

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