Click here to ask an associate for production status of specific part numbers.

High-Speed Quad RS-422/RS-485 Receivers with ±65V Fault Protection, ±25V CMR, and ±25kV ESD Protection

MAX33076E/MAX33077E
MAX33078E/MAX33079E

General Description

The MAX33076-9E is a family of robust quad channel RS-485/422 receivers with high CMR (common mode range), high fault protection, and high ESD for harsh electrical environments. This family operates from a supply range of +3.3V or +5.0V.

These devices feature a high CMR of ±25V, which helps in reception of messages when the ground planes between two nodes have large differences or large external interference from motors or other electrical noise sources. These parts have extended fault protection of ±65V where the data lines are protected from accidental shorts to local power supplies. A high ESD HBM (human body model) of ±25kV also protects the data lines from ESD strikes either during production or in the field.

The MAX33076E-79E have true fail circuitry where the receiver output is placed in a high state when open, shorted, or connected to a terminated transmission line with all drivers disabled. For part numbers MAX33076/7E, the G and $\bar{G}$ pins configure for active high and active low respectively, as well as enable or disable the outputs. They are pin compatible with MAX3095-96. For part numbers MAX33078/9E, the EN12 and EN34 pins enable Y1/Y2 and Y3/Y4 outputs respectively, and are pin compatible with MAX3093-94.

The entire family is encased in a 16-pin SOIC and QSOP package and rated over the -40°C to +125°C temperature range.

Applications

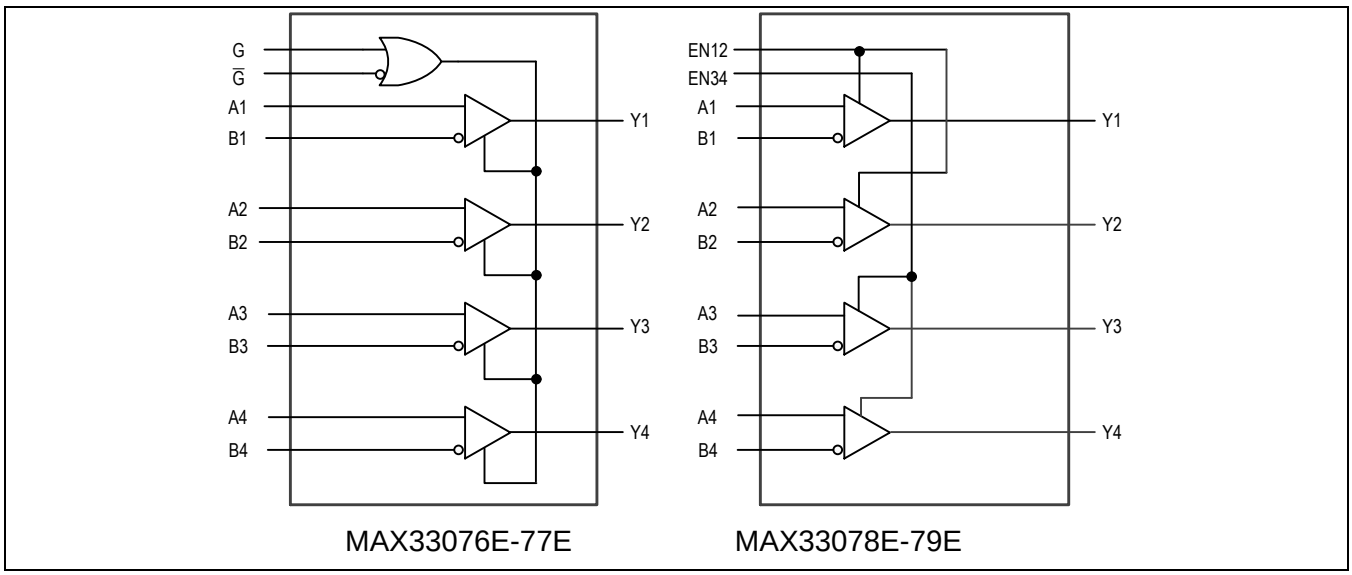
- Motor Controllers
- Telecom Equipment
- Power Grid Equipment
- CNC Machines
- Laser Modules

Benefits and Features

- Integrated Protection Increases Robustness
  - ±65V Fault Tolerant Quad Receiver Lines
  - ±25kV ESD HBM
  - ±25V Common Mode Range
  - True Fail-Safe Receiver Prevents False Transition on Receiver Input Short or Open Events
  - -40°C to +125°C Operating Temperature Range
- Industry Standard for Easy Upgrade
  - 16-Pin SOIC and QSOP Packages
  - Pin Out Compatible to Industry Standard MAX3093-94 and MAX3095-96 Product Families
  - Supply Voltage of +3.3V or +5.0V
  - Data Rate Options of 20Mbps or 35Mbps

19-101206; Rev 0; 2/22

Simplified Block Diagram



MAX33076E-77E MAX33078E-79E

Absolute Maximum Ratings

V_{CC} .....-0.3V to +6V

Y_..... -0.3V to V_{CC} + 0.3V

G, G̃, EN12, EN34.....-0.3V to 6V

A_, B_ (Continuous) .....-70V to +70V

Short-Circuit Duration (Y_, A_, B_).....Continuous

Continuous Power Dissipation (16-pin SOIC, T_A = 70°C) 1066.7mW

Continuous Power Dissipation Derating (16-pin SOIC, T_A > 70°C) ..... 13.3mW/°C

Continuous Power Dissipation (16-pin QSOP, T_A = 70°C) 761.9mW

Continuous Power Dissipation Derating (16-pin QSOP, T_A > 70°C) .....9.52mW/°C

Operating Temperature Range ..... -40°C to 125°C

Junction Temperature ..... 150°C

Lead Temperature (soldering, 10s) ..... 300°C

Soldering Temperature (reflow)..... 260°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.

Package Information

Package Code	E16+11C
Outline Number	*21-0055*
Land Pattern Number	*90-0167*
Thermal Resistance, Four Layer Board:	
Junction-to-Ambient (θ_{JA})	105°C/W
Junction-to-Case Thermal Resistance (θ_{JC})	37°C/W

Package Code	S16+1C
Outline Number	*21-0041*
Land Pattern Number	*90-0097*
Thermal Resistance, Four Layer Board:	
Junction-to-Ambient (θ_{JA})	75.0°C/W
Junction-to-Case Thermal Resistance (θ_{JC})	24.0°C/W

For the latest package outline information and land patterns (footprints), go to *www.maximintegrated.com/packages*. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to *www.maximintegrated.com/thermal-tutorial*.

Electrical Characteristics

(V_{CC} = 3.0V to 3.6V and V_{CC} = 4.5V to 5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at 5V and T_A = 25°C.) (Notes 1 and 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Power Supply	V_{CC}		3.0		3.6	V
			4.5		5.5	
Supply Current	I_{CC}	No load, no data, all channels enabled		9.0		mA
Shutdown Current	I_{SHDN}	All channels disabled		400		µA
RECEIVER						
Common Mode Range	V_{CM}		-25		+25	V
Differential Input Threshold	V_{TH}	Across common mode range	-200		+200	mV
Input Hysteresis	V_{INHYS}	Across common mode range		200		mV
Input Current (A_, B_)	I_{IN}	V_{CC} = 0V or 5.5V, V_{IN} = -25V			520	µA
		V_{CC} = 0V or 5.5V, V_{IN} = +25V			-520	
Enable Input Current (G, $\bar{G}$, EN12, EN34)	I_{INEN}				±1	µA
Enable Input High Voltage (G, $\bar{G}$, EN12, EN34)	V_{IH}		2			V
Enable Input Low Voltage (G, $\bar{G}$, EN12, EN34)	V_{IL}				0.8	V
Output High Voltage	V_{OH}	V_{ID} = 200mV, I_{SOURCE} = 3mA, output enabled	V_{CC} – 0.4			V
Output Low Voltage	V_{OL}	V_{ID} = -200mV, I_{SINK} = 3mA, output enabled			0.4	V
Y_ Short Circuit Current	I_{SC}		-80		+80	mA
Input Resistance	R_{IN}		48			kΩ
PROTECTION						
Thermal Shutdown Threshold	T_{SHDN}			+160		°C
Thermal Shutdown Hysteresis	T_{HYST}			12		°C
ESD Protection (A_, B_)		Human Body Model (JEDEC JS-001-2017)		±25		kV
		IEC 61000-4-2 Air Gap		±4		
		IEC 61000-4-2 Contact Discharge		±4		
ESD Protection (All Other Pins)		Human Body Model		±4		kV
		Charge Device Model		±4		
Fault Protection Range (A_, B_ Pins to GND)		A_, B_ independently or simultaneously	-65		+65	V
		A and B opposite polarity from separate supplies simultaneously	-65		+65	
SWITCHING (MAX33076E, MAX33078E*)						
Data Rate			20			Mbps
Propagation Delay	t_{PLH}, t_{PHL}				75	ns

(V_{CC} = 3.0V to 3.6V and V_{CC} = 4.5V to 5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at 5V and T_A = 25°C.) (Notes 1 and 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Propagation-Delay Skew	t_{SK}				20	ns
Output Enable Time to Low Level	t_{ZL}				100	ns
Output Enable Time to High Level	t_{ZH}				2000	ns
Output Disable Time from Low Level	t_{LZ}				400	ns
Output Disable Time from High Level	t_{HZ}				400	ns
Time to Failsafe	t_{FS}			10		µs
SWITCHING (MAX33077E*, MAX33079E*)						
Data Rate			35			Mbps
Propagation Delay	t_{PLH}, t_{PHL}				40	ns
Propagation-Delay Skew	t_{SK}				10	ns
Output Enable Time to Low Level	t_{ZL}				10	ns
Output Enable Time to High Level	t_{ZH}				2000	ns
Output Disable Time from Low Level	t_{LZ}				400	ns
Output Disable Time from High Level	t_{HZ}				400	ns
Time to Failsafe	t_{FS}			10		µs

Note 1: All devices are 100% production tested at T_A = +25°C. Specifications over temperature are guaranteed by design.

Note 2: All currents into the device are positive; all currents out of the device are negative. All voltages are referred to device ground, unless otherwise noted.

Timing Diagrams

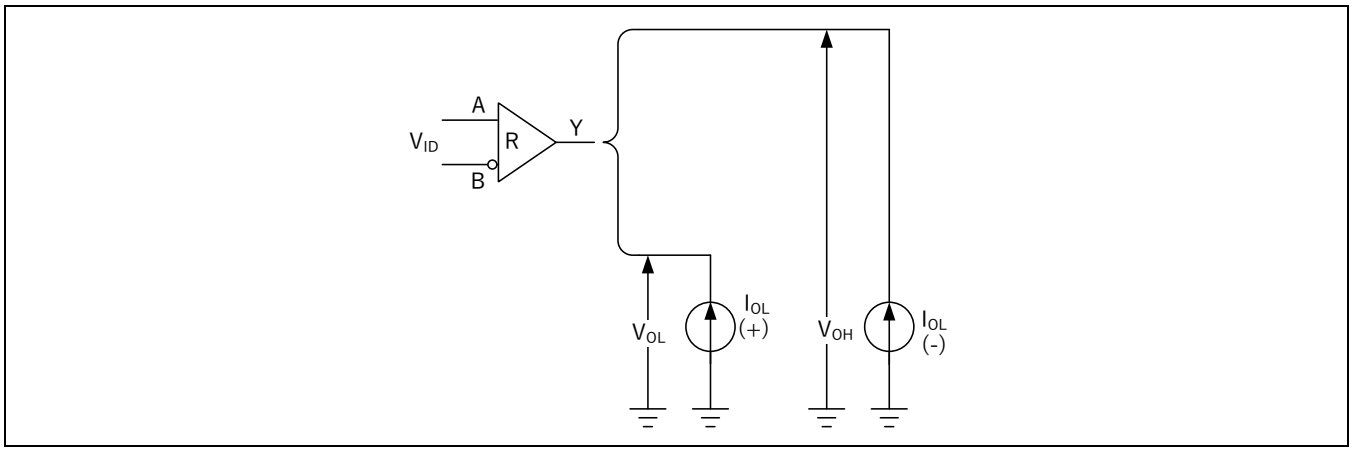


Figure 1. Receiver V_{OH} and V_{OL}

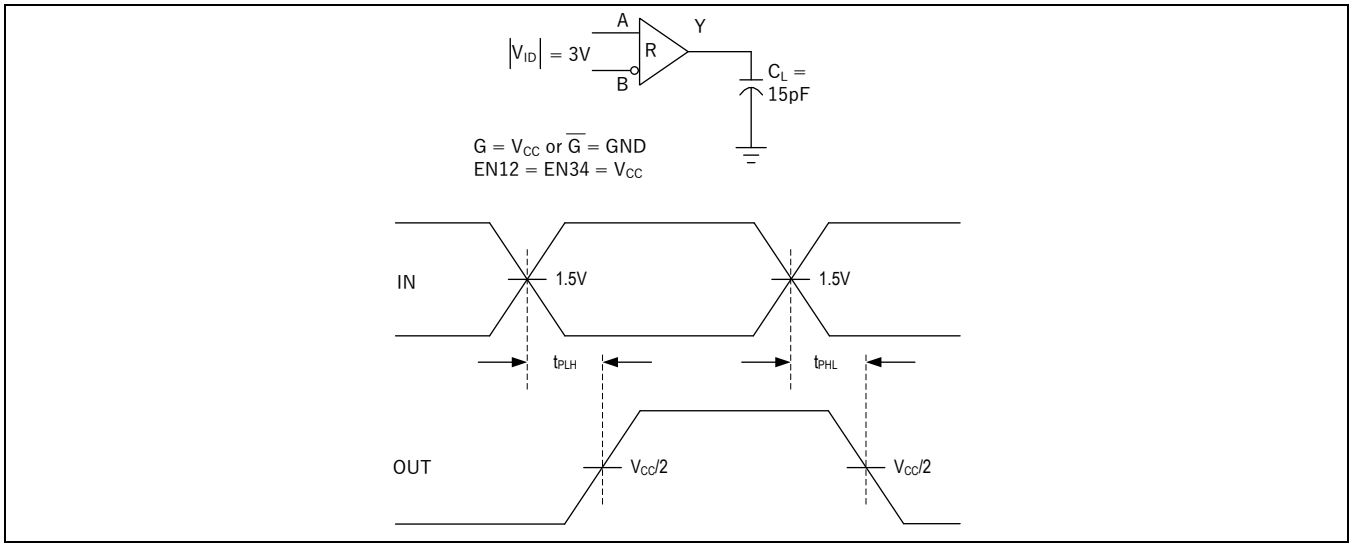


Figure 2. Receiver Propagation Delay

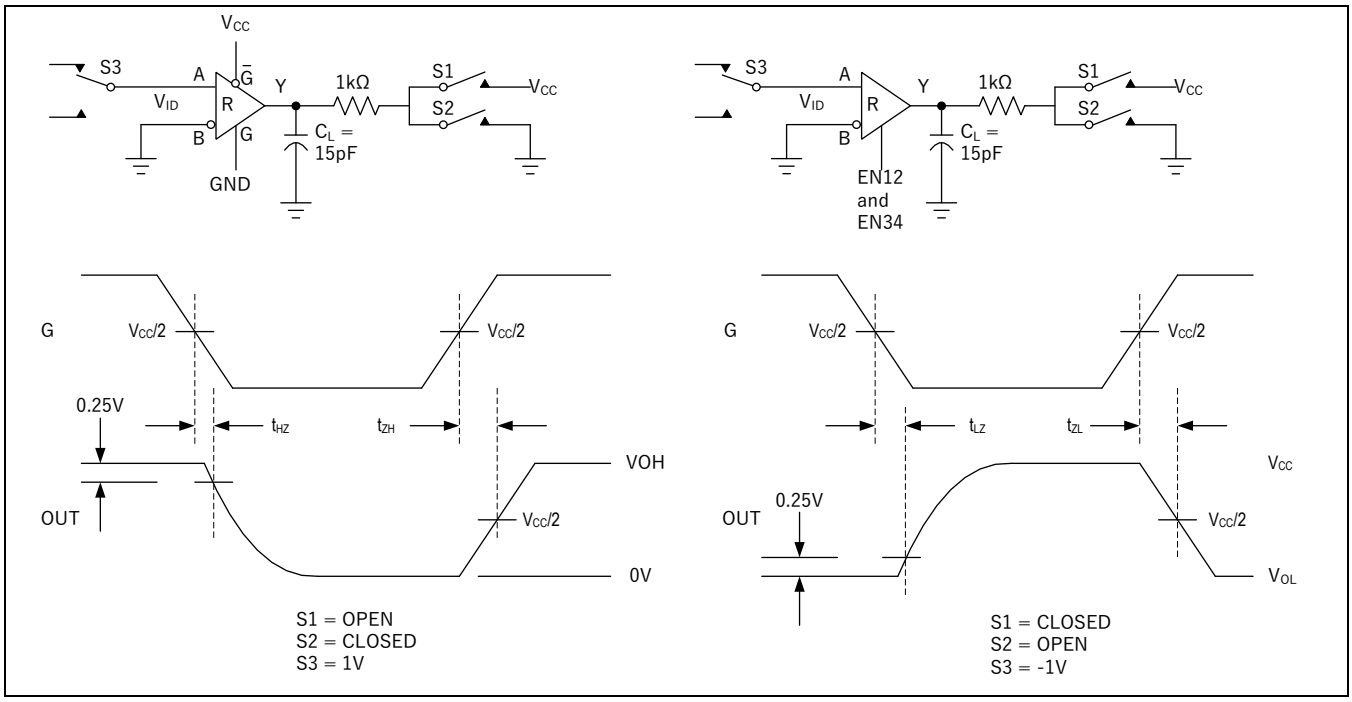
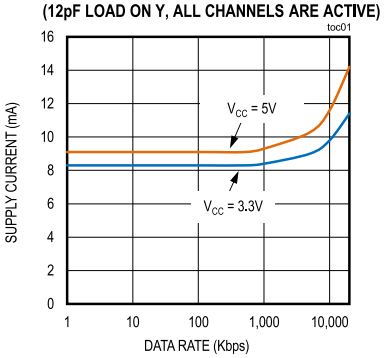


Figure 3. Receiver Enable and Disable Times

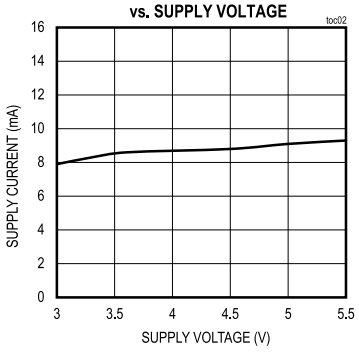
Typical Operating Characteristics

(V_{CC} = 5V, T_A = +25°C, unless otherwise noted.)

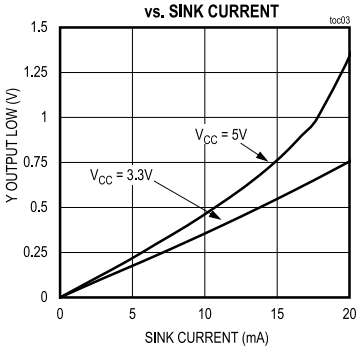
SUPPLY CURRENT vs. DATA RATE
(12pF LOAD ON Y, ALL CHANNELS ARE ACTIVE)



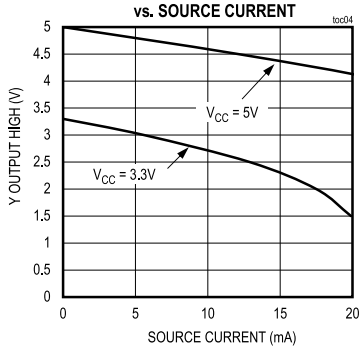
QUIESCENT CURRENT vs. SUPPLY VOLTAGE



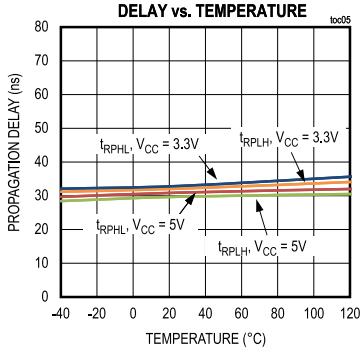
Y OUTPUT LOW VOLTAGE vs. SINK CURRENT



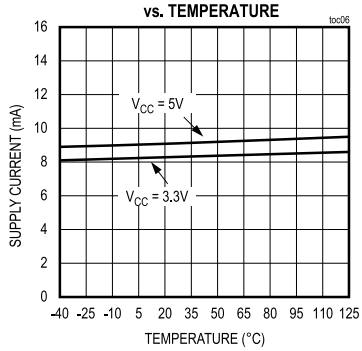
Y OUTPUT HIGH VOLTAGE vs. SOURCE CURRENT



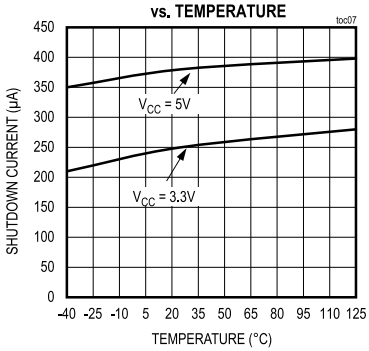
RECEIVER PROPAGATION DELAY vs. TEMPERATURE



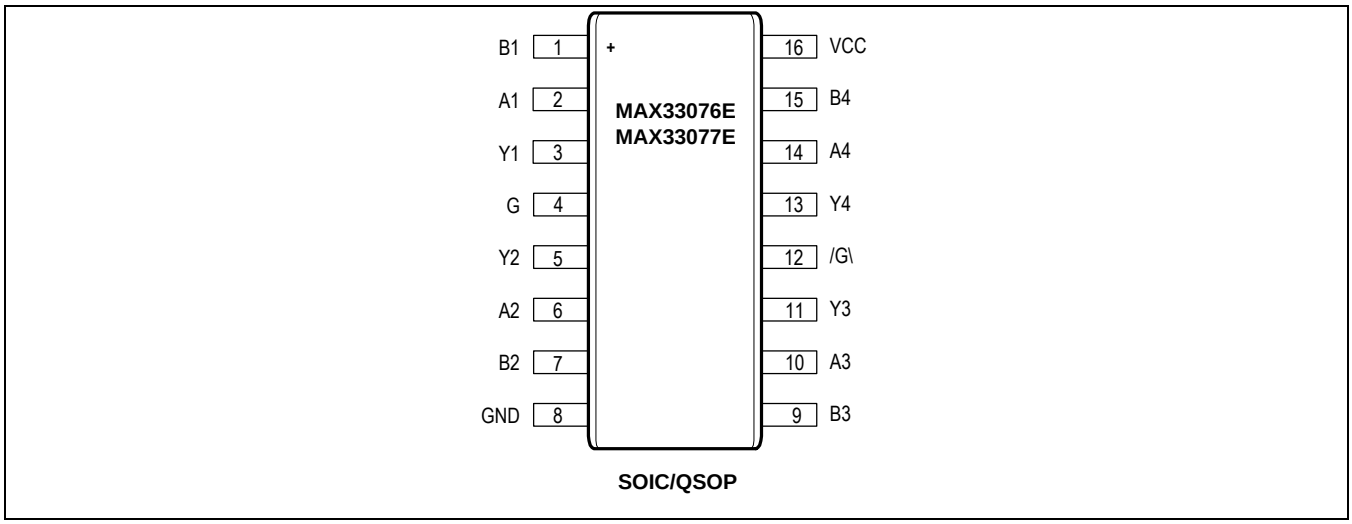
QUIESCENT CURRENT vs. TEMPERATURE



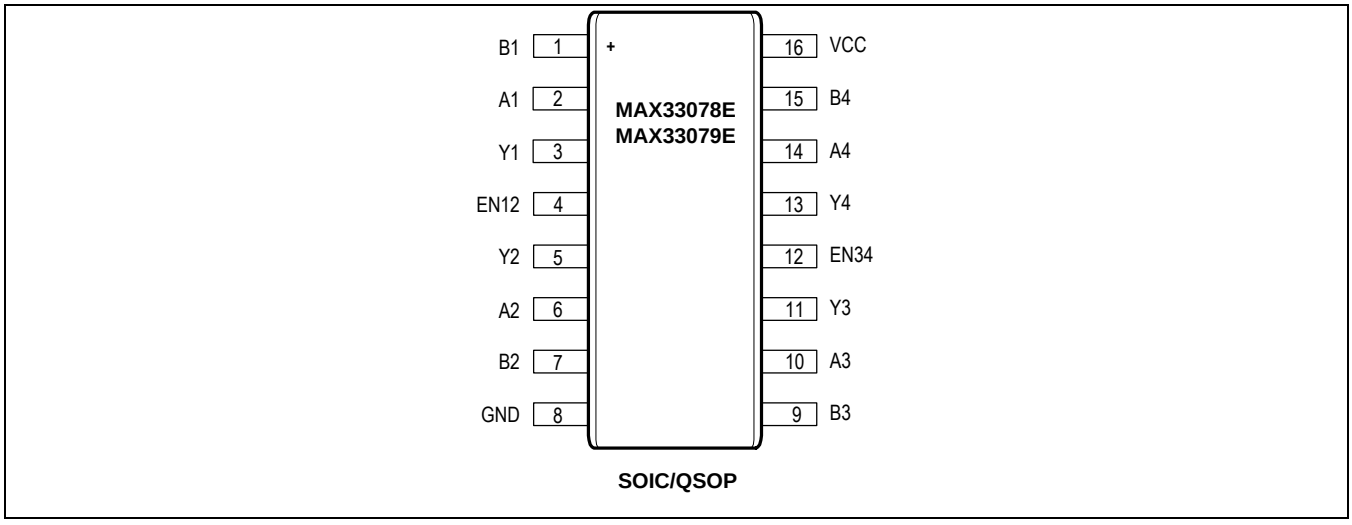
SHUTDOWN CURRENT vs. TEMPERATURE



Pin Configurations



SOIC/QSOP



SOIC/QSOP

Pin Descriptions

PIN		NAME	FUNCTION
MAX33076E-77E	MAX33078E-79E		
1	1	B1	Channel 1 Inverting Receiver Input
2	2	A1	Channel 1 Noninverting Receiver Input
3	3	Y1	Channel 1 Receiver Output. Enabled when G = high or $\overline{G}$ = low. Y1 is logic-high if $V_{A1} > V_{B1}$ by 200mV, and logic-low if $V_{A1} < V_{B1}$ by 200mV. Y1 is logic-high if V_{A1} and V_{B1} remain unconnected. Otherwise, the state is undetermined. Y1 goes high impedance when the G = low and $\overline{G}$ = high.
4		G	Active-High Receiver Output Enable. A logic-high on this input enables all receivers. When G is low and $\overline{G}$ is high, all receivers are shut down, and the outputs go high impedance.
	4	EN12	Receivers Output 1 and 2 Enable High. A logic high on this input enables receivers 1 and 2.
5	5	Y2	Channel 2 Receiver Output. Same functionality as Y1.
6	6	A2	Channel 2 Noninverting Receiver Input
7	7	B2	Channel 2 Inverting Receiver Input
8	8	GND	Ground
9	9	B3	Channel 3 Inverting Receiver Input
10	10	A3	Channel 3 Noninverting Receiver Input
11	11	Y3	Channel 3 Receiver Output. Same functionality as Y1.
12		$\overline{G}$	Active-Low Receiver Output Enable. A logic-low on this input enables all receivers. When $\overline{G}$ = high and G = low, all receivers are shut down and the outputs go high impedance.
	12	EN34	Receiver Output 3 and 4 Enable High. A logic high on this input enables receivers 3 and 4.
13	13	Y4	Channel 4 Receiver Output. Same functionality as Y1.
14	14	A4	Channel 4 Noninverting Receiver Input
15	15	B4	Channel 4 Inverting Receiver Input
16	16	VCC	Positive Supply

Detailed Description

The MAX33076-9E is a family of robust quad channel RS-485/422 receivers with high common-mode range (CMR), high fault protection, and high ESD for harsh electrical environments. This family operates from a supply of +3.3V or +5.0V.

These devices feature a high CMR of ±25V, which helps in reception of messages when the ground planes between two nodes have large differences or large external interference from motors or other electrical noise sources. These parts have extended fault protection of ±65V where the data lines are protected from accidental shorts to local power supplies. A high ESD human body model (HMB) of ±25kV also protects the data lines from ESD strikes either during production or in the field.

The MAX33076E-79E have true fail circuitry where the receiver output is placed in a logic high state when the inputs are open or shorted. For part numbers MAX33076/7E, the G and $\overline{G}$ pins configure for active high and active low respectively, as well as enable or disable the outputs. They are pin compatible with MAX3095-96. For part numbers MAX33078/9E, the EN12 and EN34 pins enable Y1/Y2 and Y3/Y4 outputs respectively, and are pin compatible with MAX3093-94.

Receiver

The receiver accepts a RS-485/422 differential input signal on A_ and B_ inputs and transfers it to a single-ended, logic-level output Y_. The RS-485 standard specifies the receiver output state to be logic high or one for differential input voltage of $V_{AB} \geq +200mV$ and logic low or zero for $V_{AB} \leq -200mV$. If the differential receiver input V_{AB} is between ±200mV, the receiver output is not defined and can be either high or low.

Low Power Shutdown Mode

The MAX33076/7E enter shutdown when G is low and $\overline{G}$ is high for at least 400ns. In shutdown mode, all outputs go high impedance and the devices typically draw 400µA. The devices exit shutdown by taking G high or $\overline{G}$ low.

Table 1. MAX33076E/77E Outputs Truth Table

G	$\overline{G}$	(V_A-V_B)	OUTPUT Y_	DEVICE MODE
1	X	≥200mV	1	On
1	X	≤-200mV	0	On
1	X	Open, Short	1	On
X	0	≥200mV	1	On
X	0	≤-200mV	0	On
X	0	Open, Short	1	On
0	1	X	High-Z	Shutdown

X = don't care, High-Z = high impedance

Table 2. MAX22078E/79E Outputs Y1 and Y2 Truth Table

EN12	EN34	(V_A-V_B)	OUTPUT Y1 OR Y2	DEVICE MODE
1	X	≥200mV	1	On
1	X	≤-200mV	0	On
1	X	Open, Short	1	On
0	1	X	High-Z	On
0	0	X	High-Z	Shutdown

Table 3. MAX33078E/79E Outputs Y3 and Y4 Truth Table

EN12	EN34	(V_A-V_B)	OUTPUT Y3 OR Y4	DEVICE MODE
X	1	≥200mV	1	On
X	1	≤-200mV	0	On
X	1	Open, Short	1	On
1	0	X	High-Z	On
0	0	X	High-Z	Shutdown

Common Mode Range

The RS-485 standard defines the common-mode range as -7V to +12V for the receiver. For the MAX33076-9E family, the common-mode range exceeds the standard with ±25V. This feature was specifically designed for systems where there is a large common-mode voltage present due to either nearby electrically noisy equipment or large ground differences due to different earth grounds or operating from different power transformers.

True Fail Safe

This family incorporates true fail-safe circuitry to ensure a known output high state when a fault is detected. The three fault scenarios are: both wires are disconnected or broken and causes an open circuit, a short circuit caused by miswire or insulation breakdown between a twisted wire pair, or when it is connected to a terminated transmission line with all drivers disabled. The output goes logic high when the inputs are between ±50mV for more than 10µs.

Fault Protection

To reduce system complexity and the need for external protection, the receiver inputs of these devices are designed to withstand voltage faults up to ±65V with respect to ground without damage. This type of fault typically occurs in the field when service personnel accidentally short the local power supply lines to the input receiver lines. These inputs are capable of tolerating ±65V whether the device is powered or unpowered.

Applications Information

The MAX33076-9E, a family of quad receivers, offer premium performance with a highly integrated, robust feature set of fault protection, common-mode range, and ESD protection. Whether used for point to point or multipoint bus receiver system, careful and sound design methodology need to be taken for optimal performance.

Power Supply Decoupling

Place a small 0.1µF decoupling capacitor at the V_{CC} pin. This capacitor acts like a local energy reservoir and helps filter out voltage spikes and pass DC component.

Layout Guidelines

- Separate the solid ground and power planes for lowest impedance and inductance to minimize noise. This also helps get the best possible conduction and reduces external influences of EMI noise.
- Keep the PCB traces as short as possible between the receiver and the connector to minimize attenuation and reflection.
- Place the decoupling capacitor and termination resistor as close to the receiver as possible. This helps minimize parasitic capacitance.
- For signal integrity, route the receiver inputs away from the supply lines. Likewise, route the receiver outputs away from supply lines.
- For a multipoint bus, keep stub length to a minimum to avoid reflections on the line. The higher the data rate, the shorter the stub length. A good rule of thumb for maximum stub length is to keep it shorter than 1/10 the driver rise time per the following formula:

$$L_{stubmax} = \frac{tr}{10} \times v \times c,$$

where

tr = the rise time of the driver

v = signal velocity as a percentage of c

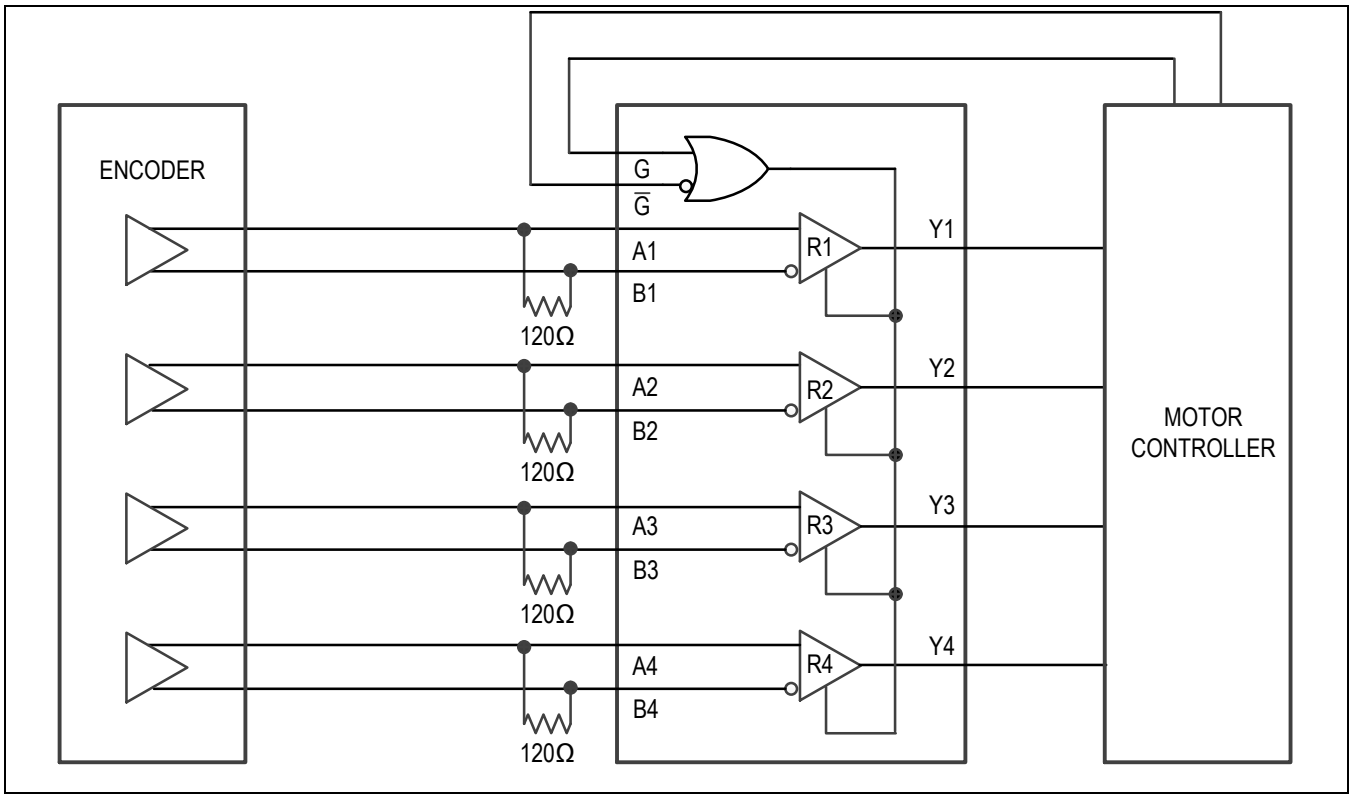
c = speed of light (9.8×10^8 ft/s)

A conservative signal velocity of 40% is a good estimate for a standard FR4 substrate and 60% for the cable. For a more accurate calculation, look for the velocity factor in a cable data sheet, which is determined by the dielectric material of the cable.

Cable

It is recommended to use a twisted pair of 24AWG cables with an impedance between 100Ω and 130Ω, a capacitance less than 100pF per meter between conductors, and a capacitance less than 200pF per meter between conductors and cable shield. Shielded CAT5 or similar Ethernet cable can be used as well.

Typical Application Circuits



Ordering Information

PART NUMBER	TEMP RANGE	PIN-PACKAGE	DATA RATE	ENABLE
MAX33076EAEE+*	-40°C to +125°C	16 QSOP	20Mbps	G, $\overline{G}$
MAX33076EASE+	-40°C to +125°C	16 SOIC	20Mbps	G, $\overline{G}$
MAX33077EAEE+*	-40°C to +125°C	16 QSOP	35Mbps	G, $\overline{G}$
MAX33077EASE+*	-40°C to +125°C	16 SOIC	35Mbps	G, $\overline{G}$
MAX33078EAEE+*	-40°C to +125°C	16 QSOP	20Mbps	EN12, EN34
MAX33078EASE+*	-40°C to +125°C	16 SOIC	20Mbps	EN12, EN34
MAX33079EAEE+*	-40°C to +125°C	16 QSOP	35Mbps	EN12, EN34
MAX33079EASE+*	-40°C to +125°C	16 SOIC	35Mbps	EN12, EN34

**Future product—contact factory for availability.*

+Denotes a lead(Pb)-free/RoHS-compliant package.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/22	Release for Market Intro	—