

# RS-485收发器，集成低压差稳压器和AutoDirection控制

MAX13410E-MAX13415E

## 概述

MAX13410E-MAX13415E为半双工RS-485/RS-422兼容收发器，针对隔离应用进行优化。这些器件具有低压差稳压器(LDO)、驱动器和接收器。内部LDO允许器件采用高达28V的非稳压电源供电。AutoDirection功能可减少隔离应用中所必需的光电耦合器的数量。其它特性包括增强ESD保护、失效保护电路、压摆率限制，可全速运行。

MAX13410E-MAX13415E的内部LDO产生一路 $5V \pm 10\%$ 的电源电压，为其内部电路供电。MAX13412E-MAX13415E将该5V提供给输出端 $V_{REG}$ ，允许用户为其它外部电路提供20mA的供电，以进一步减少外部元件。MAX13410E/MAX13411E不具备5V输出，提供工业标准的引脚排列，可以方便地替代现有设计。

MAX13410E-MAX13415E具有1/8单位负载的接收器输入阻抗，允许在一条总线上挂接256个收发器。所有驱动器输出都提供人体模式的ESD保护。这些器件还包括失效保护电路(MAX13410E/MAX13411E/MAX13414E/MAX13415E)，可在接收器输入开路或短路时保证输出逻辑高电平。当端接总线的发送器被禁止时(高阻态)，接收器输出逻辑高电平。

MAX13412E/MAX13413E具有Maxim专有的AutoDirection控制，该结构省去了DE和 $\overline{RE}$ 控制信号。在隔离应用中，能够减少光电耦合器的需求，从而降低系统成本和尺寸。

MAX13410E/MAX13412E/MAX13414E具有有限摆率驱动器，可有效降低EMI，并降低由于不恰当的电缆端接所导致的反射，能够无差错地以500kbps传输数据。MAX13411E/MAX13413E/MAX13415E不带摆率限制，传输速率可达16Mbps。

MAX13410E-MAX13415E提供8引脚SO封装，带有裸焊盘，有助于改善散热，能够工作在-40°C至+85°C扩展级温度范围。

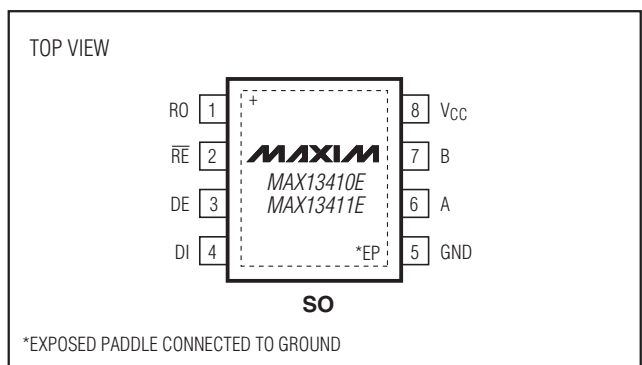
## 特性

- ◆ +6V至+28V宽电源输入范围
- ◆ +5V输出可为外部电路提供20mA电流
- ◆ 内部LDO
- ◆ 65 $\mu$ A (典型值)低关断电流
- ◆ 增强型ESD保护
  - ±15kV人体模式(MAX13412E/MAX13413E)
  - ±14kV人体模式(MAX13410E/MAX13411E)
- ◆ 1/8单位负载，允许总线挂接256个收发器
- ◆ -40°C至+85°C工作温度范围
- ◆ 失效保护
- ◆ 摆率限制和高速工作产品
- ◆ 高速工作器件的速率可达16Mbps

## 应用

|             |      |
|-------------|------|
| 隔离型RS-485接口 | 工业设备 |
| 电表          | 电信设备 |

## 引脚配置



引脚配置(续)在数据资料的最后给出。

## 订购信息/选型指南

| PART          | PIN-PACKAGE | AutoDirection | DATA RATE (max) | SLEW-RATE LIMITED | PKG CODE |
|---------------|-------------|---------------|-----------------|-------------------|----------|
| MAX13410EESA+ | 8 SO-EP*    | No            | 500kbps         | Yes               | S8E+14   |
| MAX13411EESA+ | 8 SO-EP*    | No            | 16Mbps          | No                | S8E+14   |

注：所有器件工作于-40°C至+85°C温度范围。  
+表示无铅封装。

\*EP = 裸焊盘。  
订购信息/选型指南(续)在数据资料的最后给出。

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

|  |               |
|--|---------------|
| V <sub>CC</sub> .....  | -0.3V to +30V |
| RE, DE/RE, DE, DI, RO, V <sub>REG</sub> .....  | -0.3V to +6V  |
| A, B.....  | -8V to +13V   |
| Short-Circuit Duration (RO, A, B) to GND.....  | Continuous    |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C)<br>8-Pin SO-EP (derate 19.2mW/°C above +70°C)..... | 1539mW        |

|  |                 |
|--|-----------------|
| Operating Temperature Range.....       | -40°C to +85°C  |
| Storage Temperature Range.....         | -65°C to +150°C |
| Junction Temperature.....              | +150°C          |
| θ <sub>JA</sub> (Note 1).....          | 52.0°C/W        |
| θ <sub>JC</sub> (Note 1).....          | 6.0°C/W         |
| Lead Temperature (soldering, 10s)..... | +300°C          |

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specifications JESD51-7 using a four layer board. For detailed information on package consencies refer to [www.maxim-ic.com.cn/thermal-tutorial](http://www.maxim-ic.com.cn/thermal-tutorial).

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.

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER  | SYMBOL            | CONDITIONS  | MIN | TYP  | MAX  | UNITS |
|--|-------------------|---|-----|------|------|-------|
| Supply Voltage                                     | V <sub>CC</sub>   | (Note 3)  | 6.0 |      | 28.0 | V     |
| LDO Output Voltage                                 | V <sub>REG</sub>  | V <sub>CC</sub> = +7.5V, I <sub>LOAD</sub> = 20mA           | 4.5 | 5    | 5.5  | V     |
|  |                   | V <sub>CC</sub> = +28V, I <sub>LOAD</sub> = 0mA             | 4.5 | 5    | 5.5  |       |
| LDO Output Current                                 | I <sub>REG</sub>  | V <sub>CC</sub> > +7.5V                                     |     |      | 20   | mA    |
| LDO Dropout Voltage                                | V <sub>DO</sub>   | V <sub>CC</sub> = +5V, I <sub>OUT</sub> = 20mA              |     | 0.5  |      | V     |
| Minimum Bypass Capacitor on V <sub>REG</sub>       | C <sub>S</sub>    | Guaranteed by design,<br>MAX13412E-MAX13415E                | 1   |      |      | μF    |
| Supply Current                                     | I <sub>CC</sub>   | RE, DE = high/no load<br>(MAX13410E/MAX13411E)              |     |      | 10   | mA    |
|  |                   | RE, DE/RE = high, DI = low/no load<br>(MAX13412E-MAX13415E) |     |      | 10   |       |
| Shutdown Current                                   | I <sub>SHDN</sub> | DE = low, RE = high<br>(MAX13410E/MAX13411E)                |     | 45   |      | μA    |
| Thermal-Shutdown Threshold                         | T <sub>TS</sub>   |   |     | +150 |      | °C    |
| Thermal-Shutdown Threshold Hysteresis              | T <sub>TSH</sub>  |   |     | 15   |      | °C    |
| <b>DRIVER</b>                                      |                   |   |     |      |      |       |
| Differential Driver Output                         | V <sub>OD</sub>   | R <sub>DIFF</sub> = 100Ω, Figure 1                          | 2.0 |      | 5.5  | V     |
|  |                   | R <sub>DIFF</sub> = 54Ω, Figure 1                           | 1.5 |      | 5.5  |       |
|  |                   | No load   |     |      | 5.5  |       |
| Change in Magnitude of Differential Output Voltage | ΔV <sub>OD</sub>  | R <sub>DIFF</sub> = 100Ω or 54Ω, Figure 1                   |     |      | 0.2  | V     |
| Driver Common-Mode Output Voltage                  | V <sub>OC</sub>   | R <sub>DIFF</sub> = 100Ω or 54Ω, Figure 1                   | 1   |      | 3    | V     |
| Change In Magnitude of Common-Mode Voltage         | ΔV <sub>OC</sub>  | R <sub>DIFF</sub> = 100Ω or 54Ω, Figure 1                   |     |      | 0.2  | V     |
| Input High Voltage                                 | V <sub>IH</sub>   | DI, DE, RE, DE/RE   | 2.0 |      |      | V     |
| Input Low Voltage                                  | V <sub>IL</sub>   | DI, DE, RE, DE/RE   |     |      | 0.8  | V     |
| Input Current                                      | I <sub>IN</sub>   | DI, DE, RE, DE/RE   |     |      | ±1   | μA    |
| Driver-Disable Threshold                           | V <sub>DT</sub>   | T <sub>A</sub> = +25°C (MAX13412E/MAX13413E)                | 0.6 |      | 1.0  | V     |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +6.0V$  to  $+28V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +7.5V$ ,  $C_S = 1\mu F$ , and  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER                                    | SYMBOL          | CONDITIONS   | MIN             | TYP      | MAX      | UNITS      |
|--|-----------------|--|-----------------|----------|----------|------------|
| Driver Short-Circuit Output Current          | $I_{OSD}$       | $0V \leq V_{OUT} \leq +12V$                                    |                 |          | +250     | mA         |
|  |                 | $-7V \leq V_{OUT} \leq 0V$                                     | -250            |          |          |            |
| Driver Short-Circuit-Foldback Output Current | $I_{OSDF}$      | $(V_{CC} - 1V) \leq V_{OUT} \leq +12V$                         | 20              |          |          | mA         |
|  |                 | $-7V \leq V_{OUT} \leq 0V$                                     |                 |          | -20      |            |
| <b>RECEIVER</b>                              |                 |  |                 |          |          |            |
| Input Current (A and B)                      | $I_{A, B}$      | $\overline{RE}, DE, DE/\overline{RE} =$<br>GND, $V_{CC} =$ GND | $V_{IN} = +12V$ |          | 125      | $\mu A$    |
|  |                 |  | $V_{IN} = -7V$  | -100     |          |            |
| Receiver Differential Threshold Voltage      | $V_{TH}$        | $-7V \leq V_{CM} \leq +12V$<br>(MAX13410E/MAX13411E)           | -200            |          | -50      | mV         |
|  |                 | $-7V \leq V_{LM} \leq +12V$<br>(MAX13412E/MAX13413E)           | -100            |          | 100      |            |
| Receiver Input Hysteresis                    | $\Delta V_{TH}$ | $V_A + V_B = 0V$   |                 | 15       |          | mV         |
| Output High Voltage                          | $V_{OH}$        | $I_O = -1mA, V_A - V_B \geq V_{TH}$                            | $V_{REG} - 0.6$ |          |          | V          |
| Output Low Voltage                           | $V_{OL}$        | $I_O = +1mA, V_A - V_B \leq -V_{TH}$                           |                 |          | 0.4      | V          |
| Three-State Output Current at Receiver       | $I_{OZR}$       | $0 \leq V_O \leq V_{REG}$                                      |                 | 0.01     | $\pm 1$  | $\mu A$    |
| Receiver-Input Resistance                    | $R_{IN}$        | $-7V \leq V_{CM} \leq +12V$                                    | 96              |          |          | k $\Omega$ |
| Receiver-Output Short-Circuit Current        | $I_{OSR}$       | $0V \leq V_{RO} \leq V_{REG}$                                  | $\pm 8$         |          | $\pm 95$ | mA         |
| <b>ESD PROTECTION</b>                        |                 |  |                 |          |          |            |
| ESD Protection (A, B)                        |                 | Human Body Model<br>(MAX13412E/MAX13413E)                      |                 | $\pm 15$ |          | kV         |
| ESD Protection (A, B)                        |                 | Human Body Model<br>(MAX13410E/MAX13411E)                      |                 | $\pm 14$ |          | kV         |
| ESD Protection (All Other Pins)              |                 | Human Body Model   |                 | $\pm 2$  |          | kV         |

## SWITCHING CHARACTERISTICS-MAX13410E

( $V_{CC} = +6.0V$  to  $+28V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = +7.5V$ ,  $C_S = 1\mu F$ , and  $T_A = +25^\circ C$ .) (Note 2)

| PARAMETER  | SYMBOL          | CONDITIONS  | MIN | TYP | MAX  | UNITS   |
|--|-----------------|---|-----|-----|------|---------|
| <b>DRIVER</b>  |                 |   |     |     |      |         |
| Driver Propagation Delay                                   | $t_{DPLH}$      | $R_{DIFF} = 54\Omega, C_L = 50pF,$<br>Figures 2a and 3a | 150 |     | 1000 | ns      |
|  | $t_{DPHL}$      |   | 150 |     | 1000 |         |
| Driver Differential Output Rise or Fall Time               | $t_{HL}$        | $R_{DIFF} = 54\Omega, C_L = 50pF,$<br>Figures 2a and 3a | 250 |     | 900  | ns      |
|  | $t_{LH}$        |   | 250 |     | 900  |         |
| Driver Differential Output Skew<br>$ t_{DPLH} - t_{DPHL} $ | $t_{DSKEW}$     | $R_{DIFF} = 54\Omega, C_L = 50pF,$<br>Figures 2a and 3a |     |     | 140  | ns      |
| Maximum Data Rate  | $f_{MAX}$       |   | 500 |     |      | kbps    |
| Driver Enable from Shutdown to Output High                 | $t_{DZH(SHDN)}$ | S2 closed, Figure 4,<br>$R_L = 500\Omega, C_L = 100pF$  |     |     | 11   | $\mu s$ |
| Driver Enable from Shutdown to Output Low                  | $t_{DZL(SHDN)}$ | S2 closed, Figure 4,<br>$R_L = 500\Omega, C_L = 100pF$  |     |     | 6    | $\mu s$ |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

## SWITCHING CHARACTERISTICS-MAX13410E (continued)

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                                    | SYMBOL                 | CONDITIONS  | MIN | TYP | MAX  | UNITS |
|--|------------------------|---|-----|-----|------|-------|
| Driver Enable to Output High                 | t <sub>DZH</sub>       | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 2500 | ns    |
| Driver Enable to Output Low                  | t <sub>DZL</sub>       | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 2500 | ns    |
| Driver Disable from Output High              | t <sub>DHZ</sub>       | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 100  | ns    |
| Driver Disable from Output Low               | t <sub>DLZ</sub>       | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 100  | ns    |
| Time to Shutdown                             | t <sub>SHDN</sub>      |   | 50  | 340 | 700  | ns    |
| <b>RECEIVER</b>                              |                        |   |     |     |      |       |
| Receiver Propagation Delay                   | t <sub>RPLH</sub>      | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 200  | ns    |
|  | t <sub>RPHL</sub>      |   |     |     | 200  |       |
| Receiver Output Skew                         | t <sub>RSKEW</sub>     | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 30   | ns    |
| Maximum Data Rate                            | f <sub>MAX</sub>       |   | 500 |     |      | kbps  |
| Receiver Enable to Output High               | t <sub>RZH</sub>       | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Enable to Output Low                | t <sub>RZL</sub>       | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Disable Time from High              | t <sub>RZH</sub>       | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Disable Time from Low               | t <sub>RLZ</sub>       | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Enable from Shutdown to Output High | t <sub>RZH(SHDN)</sub> | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 14   | μs    |
| Receiver Enable from Shutdown to Output Low  | t <sub>RZL(SHDN)</sub> | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 3.5  | μs    |

## SWITCHING CHARACTERISTICS-MAX13411E

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER  | SYMBOL                 | CONDITIONS  | MIN | TYP | MAX | UNITS |
|--|------------------------|---|-----|-----|-----|-------|
| <b>DRIVER</b>  |                        |   |     |     |     |       |
| Driver Propagation Delay   | t <sub>DPLH</sub>      | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a     |     |     | 50  | ns    |
|  | t <sub>DPHL</sub>      |   |     |     | 50  |       |
| Driver Differential Output Rise or Fall Time                           | t <sub>HL</sub>        | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a     |     |     | 15  | ns    |
|  | t <sub>LH</sub>        |   |     |     | 15  |       |
| Driver Differential Output Skew  t <sub>DPLH</sub> - t <sub>DPHL</sub> | t <sub>DSKEW</sub>     | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a     |     |     | 8   | ns    |
| Maximum Data Rate  | f <sub>MAX</sub>       |   | 16  |     |     | Mbps  |
| Driver Enable from Shutdown to Output High                             | t <sub>DZH(SHDN)</sub> | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 11  | μs    |
| Driver Enable from Shutdown to Output Low                              | t <sub>DZL(SHDN)</sub> | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 6   | μs    |
| Driver Enable to Output High   | t <sub>DZH</sub>       | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 70  | ns    |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

## SWITCHING CHARACTERISTICS—MAX13411E (continued)

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                                    | SYMBOL                 | CONDITIONS  | MIN | TYP | MAX | UNITS |
|--|------------------------|---|-----|-----|-----|-------|
| Driver Enable to Output Low                  | t <sub>DZL</sub>       | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 70  | ns    |
| Driver Disable from Output High              | t <sub>DHZ</sub>       | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 50  | ns    |
| Driver Disable from Output Low               | t <sub>DLZ</sub>       | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 50  | ns    |
| <b>RECEIVER</b>                              |                        |   |     |     |     |       |
| Receiver Propagation Delay                   | t <sub>RPLH</sub>      | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 75  | ns    |
|  | t <sub>RPHL</sub>      |   |     |     | 75  |       |
| Receiver Output Skew                         | t <sub>RSKEW</sub>     | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 8   | ns    |
| Maximum Data Rate                            | f <sub>MAX</sub>       |   | 16  |     |     | Mbps  |
| Receiver Enable to Output High               | t <sub>RZH</sub>       | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50  | ns    |
| Receiver Enable to Output Low                | t <sub>RZL</sub>       | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50  | ns    |
| Receiver Disable Time from High              | t <sub>RZH</sub>       | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50  | ns    |
| Receiver Disable Time from Low               | t <sub>RLZ</sub>       | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50  | ns    |
| Receiver Enable from Shutdown to Output High | t <sub>RZH(SHDN)</sub> | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 14  | μs    |
| Receiver Enable from Shutdown to Output Low  | t <sub>RZL(SHDN)</sub> | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 3.5 | μs    |

## SWITCHING CHARACTERISTICS—MAX13412E

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                                    | SYMBOL             | CONDITIONS   | MIN | TYP | MAX  | UNITS |
|--|--------------------|--|-----|-----|------|-------|
| <b>DRIVER</b>                                |                    |  |     |     |      |       |
| Driver Propagation Delay                     | t <sub>DPLH</sub>  | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figures 2b<br>and 3b | 200 |     | 1000 | ns    |
|  | t <sub>DPHL</sub>  |  | 200 |     | 1000 |       |
| Driver Differential Output Rise or Fall Time | t <sub>HL</sub>    | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figures 2b<br>and 3b | 250 |     | 900  | ns    |
|  | t <sub>LH</sub>    |  | 250 |     | 900  |       |
| Maximum Data Rate                            | f <sub>MAX</sub>   |  | 500 |     |      | kbps  |
| Driver Disable Delay                         | t <sub>DDD</sub>   | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figure 3b            |     |     | 2500 | ns    |
| <b>RECEIVER</b>                              |                    |  |     |     |      |       |
| Receiver Propagation Delay                   | t <sub>RPLH</sub>  | C <sub>L</sub> = 15pF, Figures 5 and 6                             |     |     | 200  | ns    |
|  | t <sub>RPHL</sub>  |  |     |     | 200  |       |
| Receiver Output Skew                         | t <sub>RSKEW</sub> | C <sub>L</sub> = 15pF, Figures 5 and 6                             |     |     | 30   | ns    |
| Maximum Data Rate                            | f <sub>MAX</sub>   |  | 500 |     |      | kbps  |
| Receiver Enable to Output High               | t <sub>RZH</sub>   | S2 closed, Figure 7, C <sub>L</sub> = 15pF                         |     |     | 50   | ns    |
| Receiver Enable to Output Low                | t <sub>RZL</sub>   | S1 closed, Figure 7, C <sub>L</sub> = 15pF                         |     |     | 50   | ns    |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

## SWITCHING CHARACTERISTICS-MAX13412E (continued)

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                       | SYMBOL           | CONDITIONS   | MIN | TYP | MAX  | UNITS |
|---------------------------------|------------------|--|-----|-----|------|-------|
| Receiver Disable Time from Low  | t <sub>RLZ</sub> | S1 closed, Figure 7, C <sub>L</sub> = 15pF             |     |     | 50   | ns    |
| Receiver Disable Time from High | t <sub>RZH</sub> | S2 closed, Figure 7, C <sub>L</sub> = 15pF             |     |     | 50   | ns    |
| Receiver Enable Delay           | t <sub>RED</sub> | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figure 3 |     |     | 2500 | ns    |

## SWITCHING CHARACTERISTICS-MAX13413E

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                                    | SYMBOL             | CONDITIONS  | MIN | TYP | MAX | UNITS |
|--|--------------------|---|-----|-----|-----|-------|
| <b>DRIVER</b>                                |                    |   |     |     |     |       |
| Driver Propagation Delay                     | t <sub>DPLH</sub>  | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figures 2b and 3b |     |     | 50  | ns    |
|  | t <sub>DPHL</sub>  |   |     |     | 50  |       |
| Driver Differential Output Rise or Fall Time | t <sub>HL</sub>    | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figures 2b and 3b |     |     | 15  | ns    |
|  | t <sub>LH</sub>    |   |     |     | 15  |       |
| Maximum Data Rate                            | f <sub>MAX</sub>   |   | 16  |     |     | Mbps  |
| Driver Disable Delay                         | t <sub>DDD</sub>   | R <sub>L</sub> = 110Ω, C <sub>L</sub> = 50pF, Figure 3b         |     |     | 70  | ns    |
| <b>RECEIVER</b>                              |                    |   |     |     |     |       |
| Receiver Propagation Delay                   | t <sub>RPLH</sub>  | C <sub>L</sub> = 15pF, Figures 5 and 6                          |     |     | 80  | ns    |
|  | t <sub>RPHL</sub>  |   |     |     | 80  |       |
| Receiver Output Skew                         | t <sub>RSKEW</sub> | C <sub>L</sub> = 15pF, Figures 5 and 6                          |     |     | 13  | ns    |
| Maximum Data Rate                            | f <sub>MAX</sub>   |   | 16  |     |     | Mbps  |
| Receiver Enable to Output High               | t <sub>RZH</sub>   | S2 closed, Figure 7, C <sub>L</sub> = 15pF                      |     |     | 50  | ns    |
| Receiver Enable to Output Low                | t <sub>RZL</sub>   | S1 closed, Figure 7, C <sub>L</sub> = 15pF                      |     |     | 50  | ns    |
| Receiver Disable Time from Low               | t <sub>RLZ</sub>   | S1 closed, Figure 7, C <sub>L</sub> = 15pF                      |     |     | 50  | ns    |
| Receiver Disable Time from High              | t <sub>RZH</sub>   | S2 closed, Figure 7, C <sub>L</sub> = 15pF                      |     |     | 50  | ns    |
| Receiver Enable Delay                        | t <sub>RED</sub>   | R <sub>L</sub> = 110Ω, Figure 3, C <sub>L</sub> = 50pF          |     |     | 70  | ns    |

## SWITCHING CHARACTERISTICS-MAX13414E

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER   | SYMBOL             | CONDITIONS  | MIN | TYP | MAX  | UNITS |
|---|--------------------|---|-----|-----|------|-------|
| <b>DRIVER</b>   |                    |   |     |     |      |       |
| Driver Propagation Delay  | t <sub>DPLH</sub>  | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a | 200 |     | 1000 | ns    |
|   | t <sub>DPHL</sub>  |   | 200 |     | 1000 |       |
| Driver Differential Output Rise or Fall Time                              | t <sub>HL</sub>    | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a | 250 |     | 900  | ns    |
|   | t <sub>LH</sub>    |   | 250 |     | 900  |       |
| Driver Differential Output Skew<br> t <sub>DPLH</sub> - t <sub>DPHL</sub> | t <sub>DSKEW</sub> | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a and 3a |     |     | 140  | ns    |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

## SWITCHING CHARACTERISTICS-MAX13414E (continued)

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                       | SYMBOL             | CONDITIONS  | MIN | TYP | MAX  | UNITS |
|---------------------------------|--------------------|---|-----|-----|------|-------|
| Maximum Data Rate               | f <sub>MAX</sub>   |   | 500 |     |      | kbps  |
| Driver Enable to Output High    | t <sub>DZH</sub>   | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 2500 | ns    |
| Driver Enable to Output Low     | t <sub>DZL</sub>   | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 2500 | ns    |
| Driver Disable from Output High | t <sub>DHZ</sub>   | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 100  | ns    |
| Driver Disable from Output Low  | t <sub>DLZ</sub>   | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 100pF |     |     | 100  | ns    |
| <b>RECEIVER</b>                 |                    |   |     |     |      |       |
| Receiver Propagation Delay      | t <sub>RPLH</sub>  | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 200  | ns    |
|                                 | t <sub>RPHL</sub>  |   |     |     | 200  |       |
| Receiver Output Skew            | t <sub>RSKEW</sub> | C <sub>L</sub> = 15pF (at RO), Figures 5 and 6                        |     |     | 30   | ns    |
| Maximum Data Rate               | f <sub>MAX</sub>   |   | 500 |     |      | kbps  |
| Receiver Enable to Output High  | t <sub>RZH</sub>   | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Enable to Output Low   | t <sub>RZL</sub>   | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Disable Time from Low  | t <sub>RLZ</sub>   | S1 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |
| Receiver Disable Time from High | t <sub>RZH</sub>   | S2 closed, Figure 7, C <sub>L</sub> = 15pF                            |     |     | 50   | ns    |

## SWITCHING CHARACTERISTICS-MAX13415E

(V<sub>CC</sub> = +6.0V to +28V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>CC</sub> = +7.5V, C<sub>S</sub> = 1μF, and T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER   | SYMBOL             | CONDITIONS   | MIN | TYP | MAX | UNITS |
|---|--------------------|--|-----|-----|-----|-------|
| <b>DRIVER</b>   |                    |  |     |     |     |       |
| Driver Propagation Delay  | t <sub>DPLH</sub>  | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a<br>and 3a |     |     | 50  | ns    |
|   | t <sub>DPHL</sub>  |  |     |     | 50  |       |
| Driver Differential Output<br>Rise or Fall Time                             | t <sub>HL</sub>    | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a<br>and 3a |     |     | 15  | ns    |
|   | t <sub>LH</sub>    |  |     |     | 15  |       |
| Driver Differential Output Skew<br>(t <sub>DPLH</sub> - t <sub>DPHL</sub> ) | t <sub>DSKEW</sub> | R <sub>DIFF</sub> = 54Ω, C <sub>L</sub> = 50pF, Figures 2a<br>and 3a |     |     | 8   | ns    |
| Maximum Data Rate   | f <sub>MAX</sub>   |  | 16  |     |     | Mbps  |
| Driver Enable to Output High  | t <sub>DZH</sub>   | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 15pF |     |     | 70  | ns    |
| Driver Enable to Output Low   | t <sub>DZL</sub>   | S1 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 15pF |     |     | 70  | ns    |
| Driver Disable from Output High   | t <sub>DHZ</sub>   | S2 closed, Figure 4,<br>R <sub>L</sub> = 500Ω, C <sub>L</sub> = 15pF |     |     | 50  | ns    |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

## SWITCHING CHARACTERISTICS-MAX13415E (continued)

(VCC = +6.0V to +28V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at VCC = +7.5V, CS = 1μF, and TA = +25°C.) (Note 2)

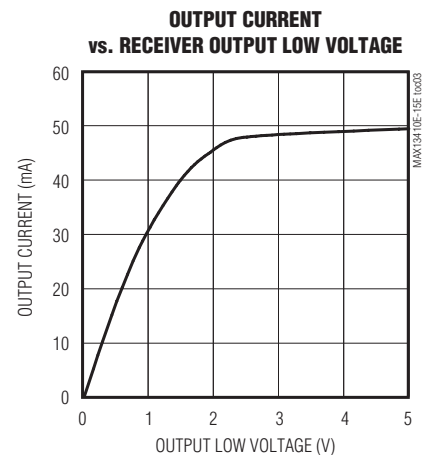
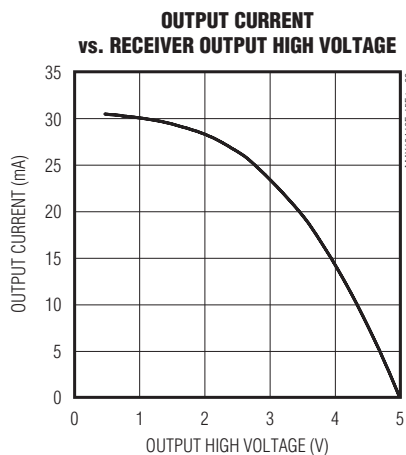
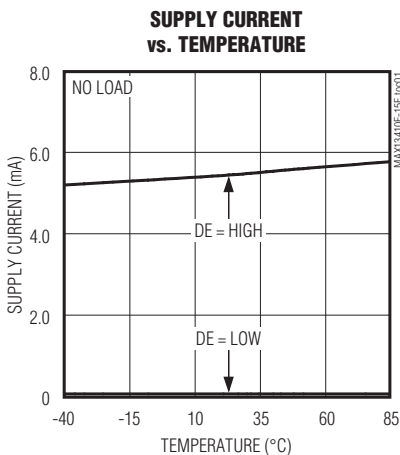
| PARAMETER                       | SYMBOL | CONDITIONS                                   | MIN | TYP | MAX | UNITS |
|---------------------------------|--------|--|-----|-----|-----|-------|
| Driver Disable from Output Low  | tDLZ   | S1 closed, Figure 4,<br>RL = 500Ω, CL = 15pF |     |     | 50  | ns    |
| <b>RECEIVER</b>                 |        |  |     |     |     |       |
| Receiver Propagation Delay      | tRPLH  | CL = 15pF (at RO), Figures 5 and 6           |     |     | 75  | ns    |
|                                 | tRPHL  |  |     |     | 75  |       |
| Receiver Output Skew            | tRSKEW | CL = 15pF (at RO), Figures 5 and 6           |     |     | 8   | ns    |
| Maximum Data Rate               | fMAX   |  | 16  |     |     | Mbps  |
| Receiver Enable to Output High  | tRZH   | S2 closed, Figure 7, CL = 15pF               |     |     | 50  | ns    |
| Receiver Enable to Output Low   | tRZL   | S1 closed, Figure 7, CL = 15pF               |     |     | 50  | ns    |
| Receiver Disable Time from Low  | tRLZ   | S1 closed, Figure 7, CL = 15pF               |     |     | 50  | ns    |
| Receiver Disable Time from High | tRZH   | S2 closed, Figure 7, CL = 15pF               |     |     | 50  | ns    |

**Note 2:** CS is the compensation capacitor on VREG for the MAX13412E-MAX13415E versions. CS must have an ESR value of 20mΩ or less.

**Note 3:** Parameters are guaranteed for +6.0V ≤ VCC ≤ +28V.

### 典型工作特性

(VCC = +7.5V, TA = +25°C, unless otherwise noted.)





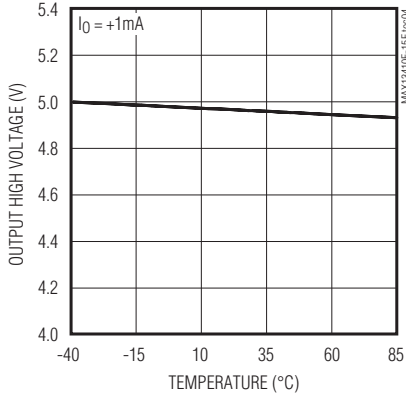
# RS-485收发器，集成低压差稳压器 和AutoDirection控制

典型工作特性(续)

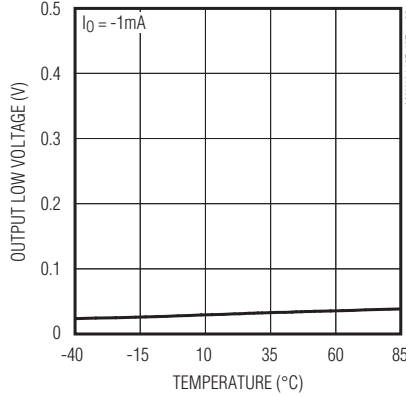
( $V_{CC} = +7.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX13410E-MAX13415E

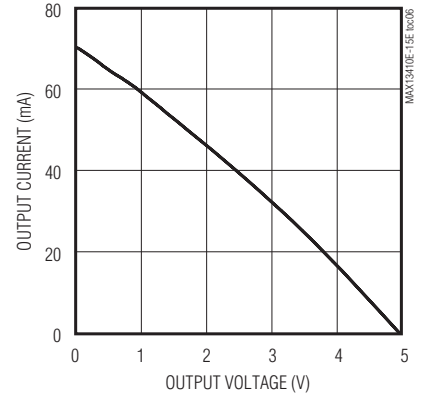
**RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE**



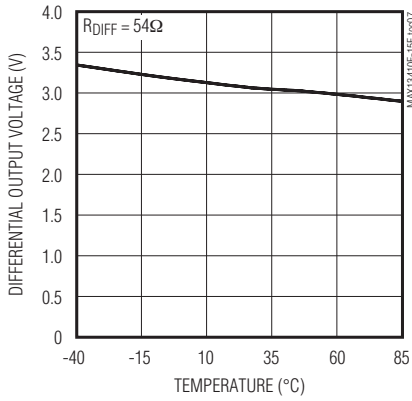
**RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE**



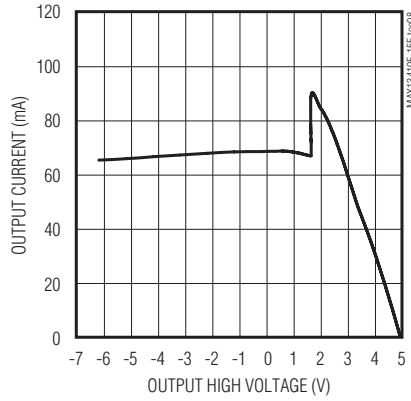
**DIFFERENTIAL OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE**



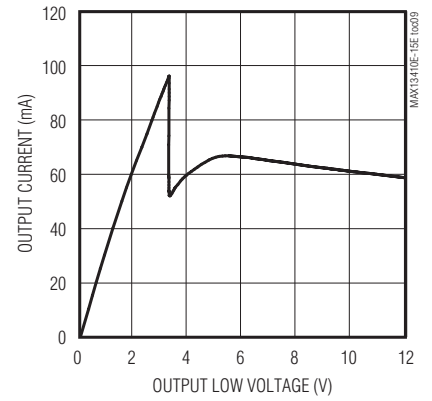
**DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs. TEMPERATURE**



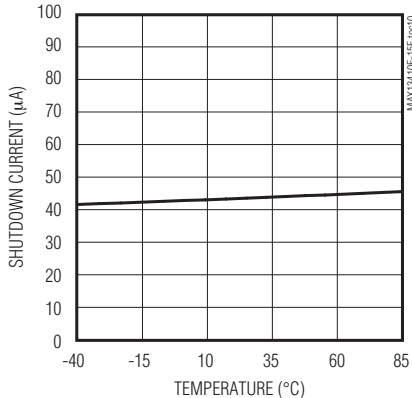
**OUTPUT CURRENT vs. TRANSMITTER OUTPUT HIGH VOLTAGE**



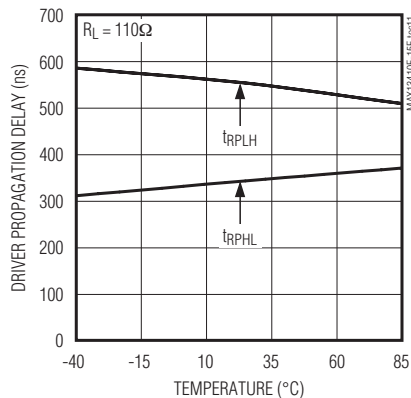
**OUTPUT CURRENT vs. TRANSMITTER OUTPUT LOW VOLTAGE**



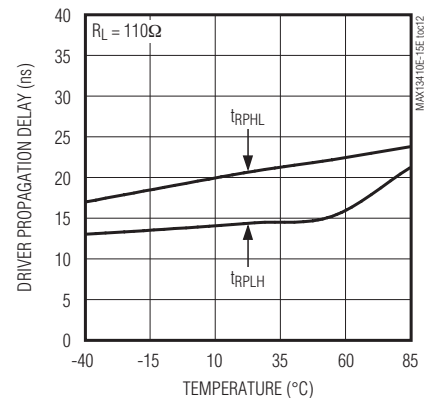
**SHUTDOWN CURRENT vs. TEMPERATURE**



**DRIVER PROPAGATION vs. TEMPERATURE (MAX13412E)**



**DRIVER PROPAGATION vs. TEMPERATURE (MAX13413E)**

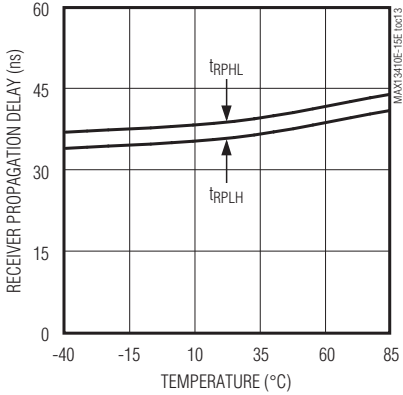


# RS-485收发器，集成低压差稳压器 和AutoDirection控制

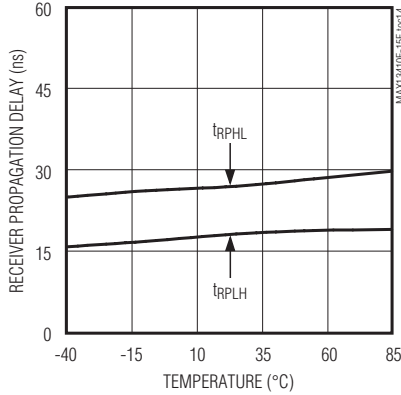
典型工作特性(续)

( $V_{CC} = +7.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

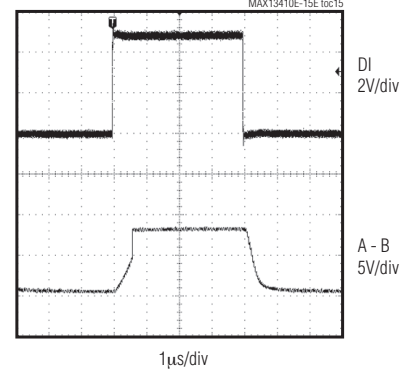
**RECEIVER PROPAGATION vs. TEMPERATURE  
(MAX13410E/MAX13412E)**



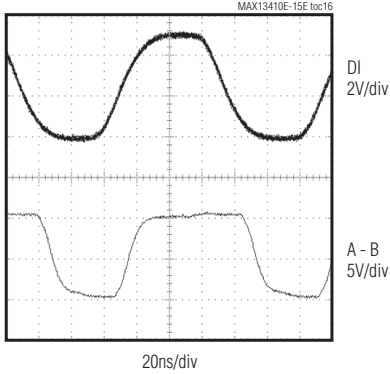
**RECEIVER PROPAGATION vs. TEMPERATURE  
(MAX13411E/MAX13413E)**



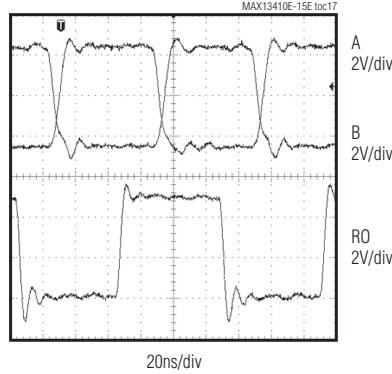
**DRIVER PROPAGATION (250kbps)  
(MAX13412E)**



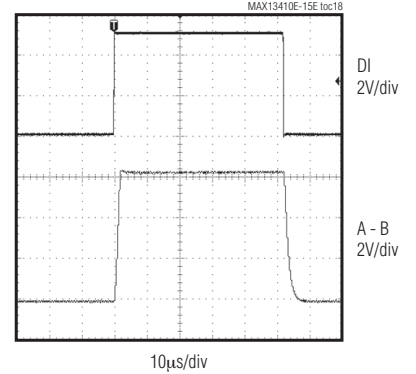
**DRIVER PROPAGATION (16kbps)  
(MAX13413E)**



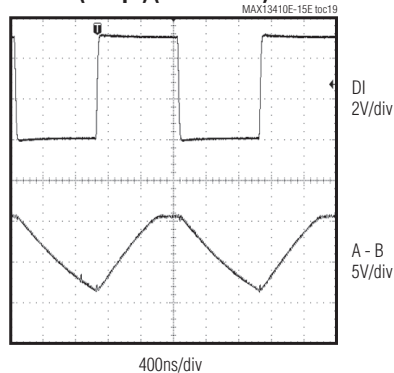
**RECEIVER PROPAGATION (16kbps)  
(MAX13413E)**



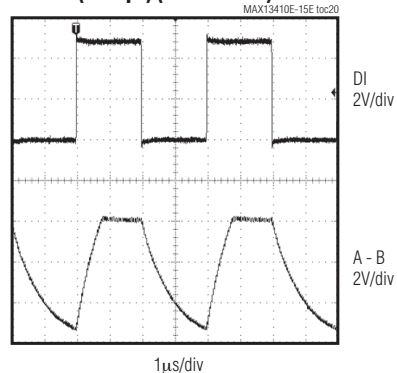
**DRIVING A LARGE CAPACITIVE LOAD 16nF  
(19.2kbps) (MAX13412E)**



**DRIVING A LARGE CAPACITIVE LOAD 16nF  
(1Mbps) (MAX13413E)**



**DRIVING A LARGE CAPACITIVE LOAD 16nF  
(50kbps) (MAX13413E)**



# RS-485收发器，集成低压差稳压器和AutoDirection控制

测试电路和波形

MAX13410E-MAX13415E

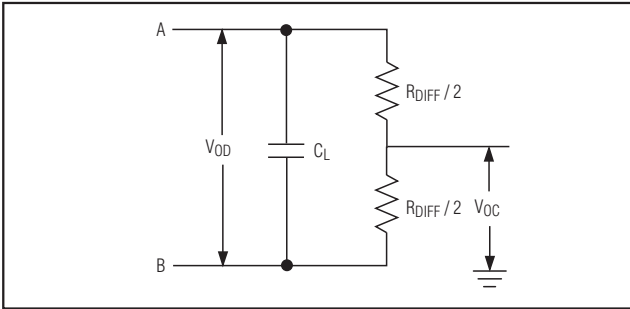


图1. 驱动器直流测试负载

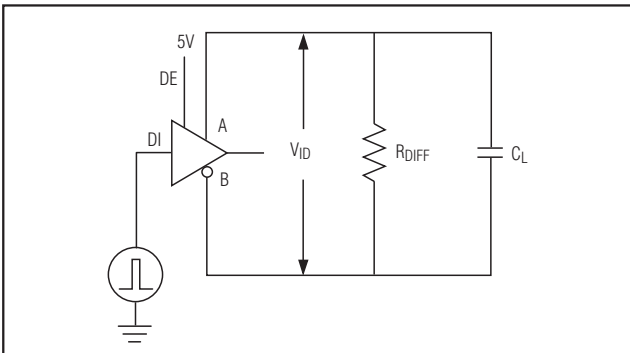


图2a. 驱动器时序测试电路

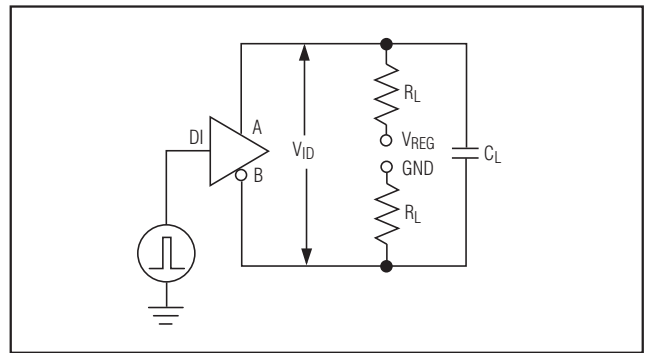


图2b. 驱动器时序测试电路

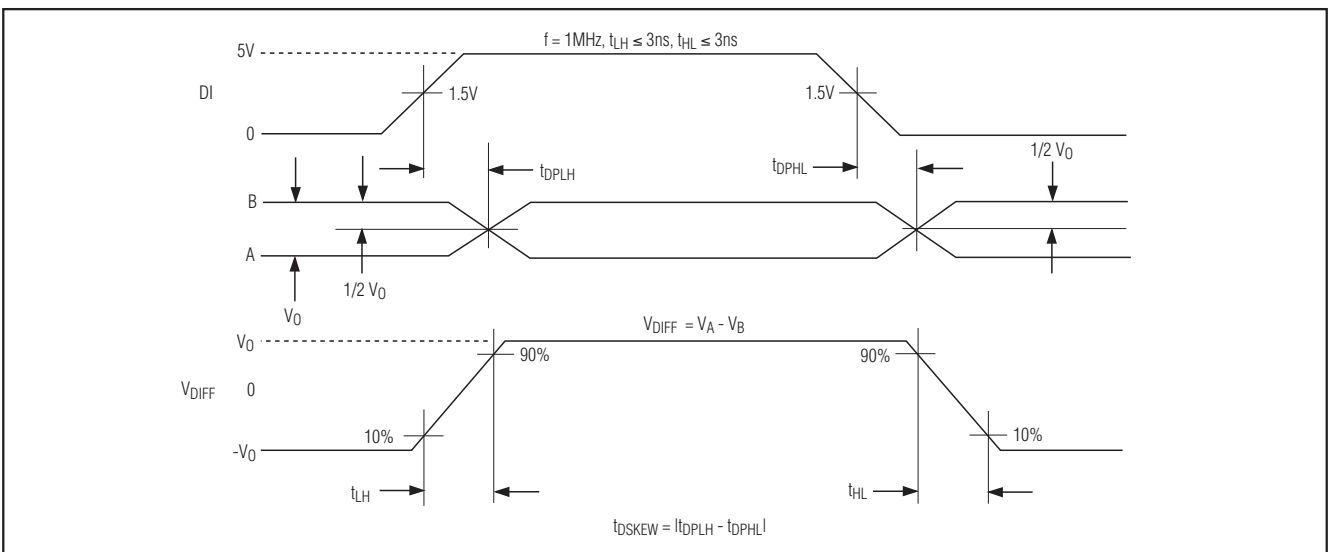


图3a. 驱动器传输延时

# RS-485收发器，集成低压差稳压器和AutoDirection控制

测试电路和波形(续)

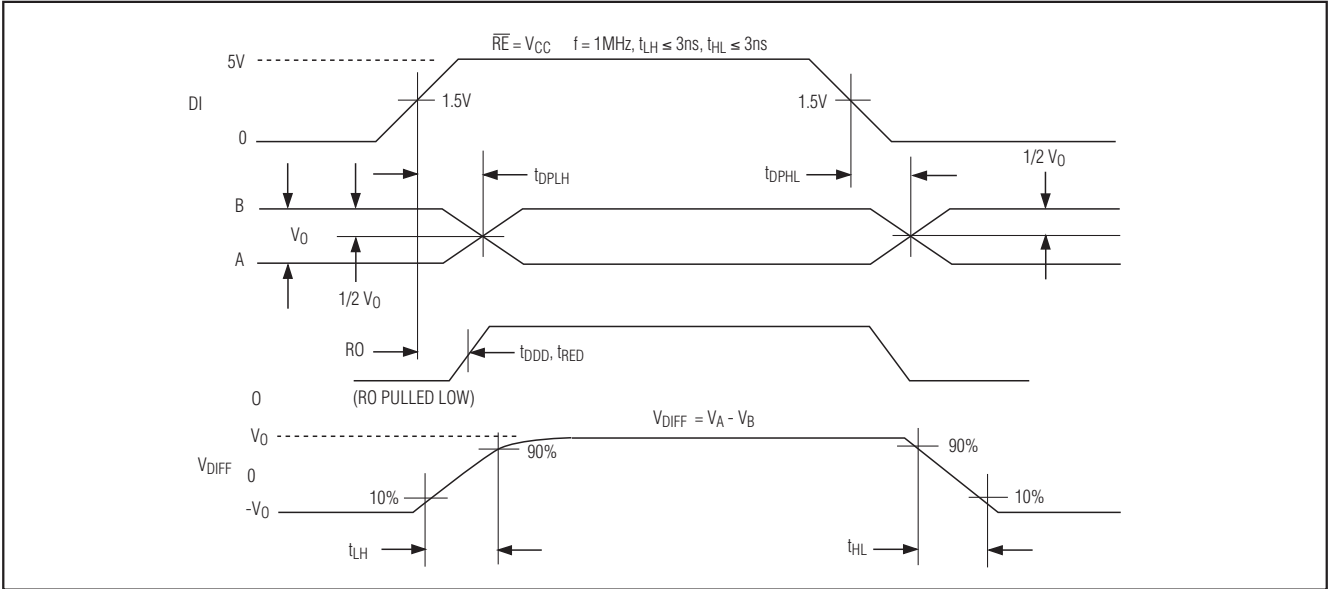


图3b. 驱动器传输延时

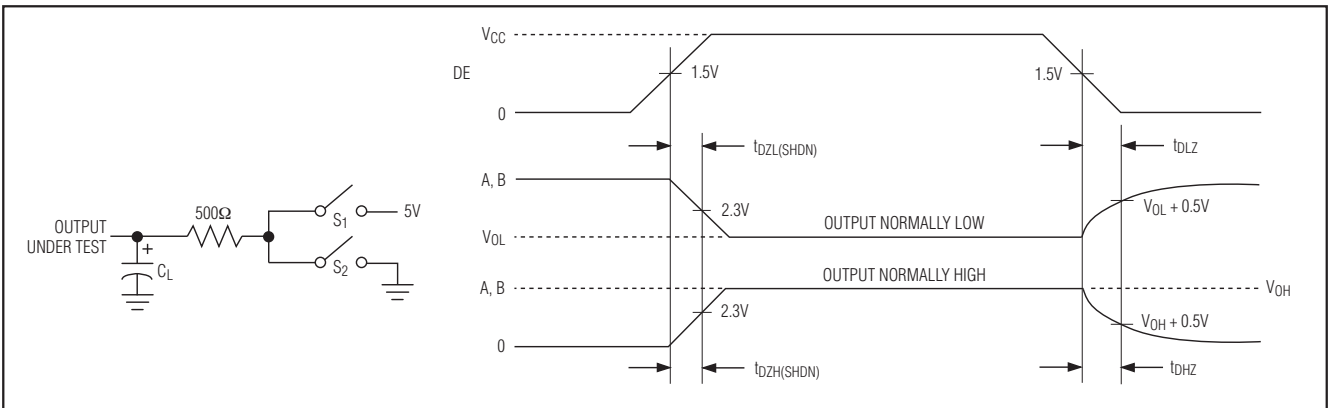


图4. 驱动器使能和禁止时间

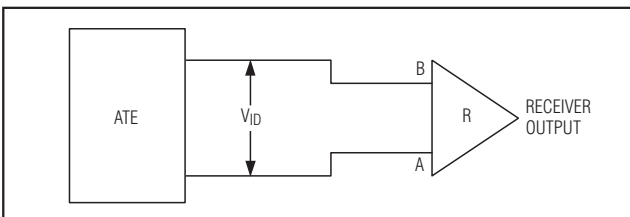


图5. 接收器传输延时测试电路

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

测试电路和波形(续)

MAX13410E-MAX13415E

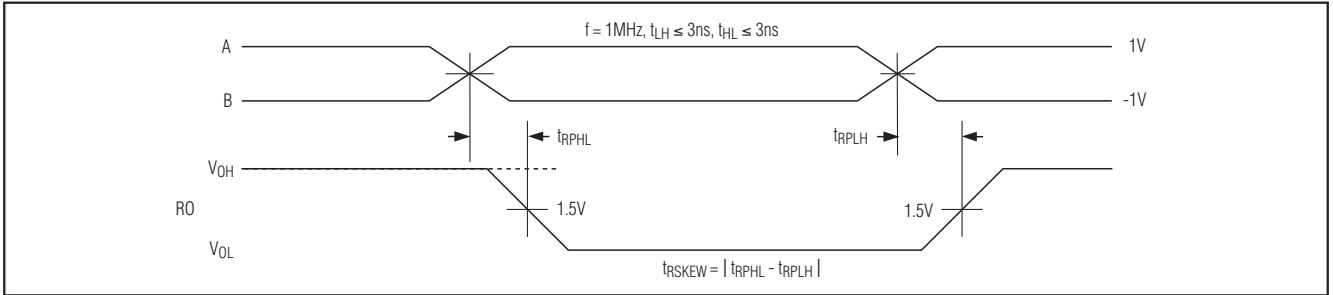


图6. 接收器传输延时

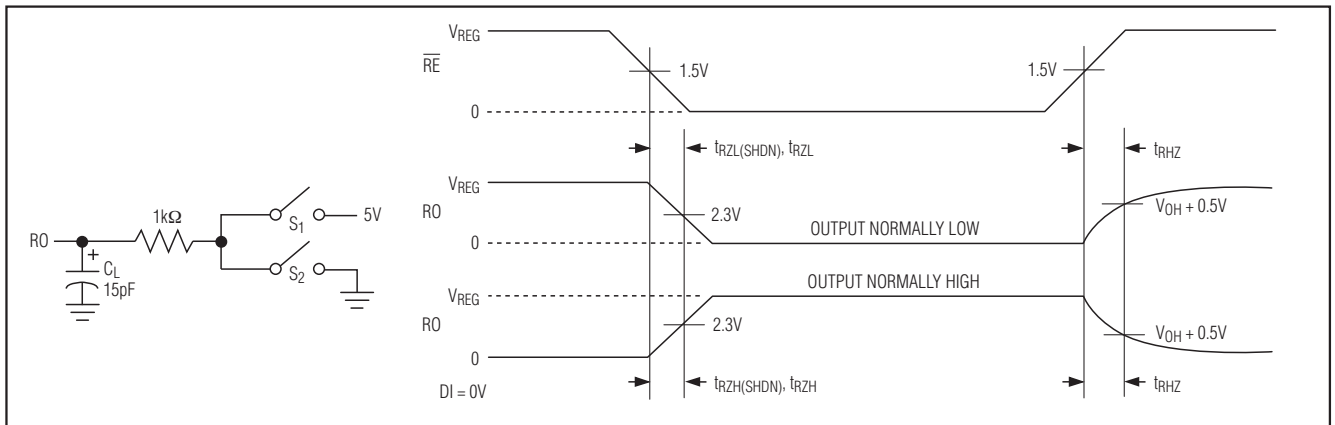


图7. 接收器使能和禁止时间

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

引脚说明

MAX13410E-MAX13415E

| 引脚                      |                         |                         | 名称                         | 功能   |
|-------------------------|-------------------------|-------------------------|----------------------------|--|
| MAX13410E/<br>MAX13411E | MAX13412E/<br>MAX13413E | MAX13414E/<br>MAX13415E |                            |  |
| 1                       | —                       | 1                       | RO                         | 接收器输出。接收器使能时，如果 $V_A - V_B \geq -50\text{mV}$ ，RO为高电平；如果 $V_A - V_B \leq -200\text{mV}$ ，则RO为低电平。 <b>注意：</b> RO以LDO输出( $V_{\text{REG}}$ )为参考。  |
| 2                       | —                       | —                       | $\overline{\text{RE}}$     | 接收器输出使能。驱动 $\overline{\text{RE}}$ 为低电平时使能RO；驱动 $\overline{\text{RE}}$ 为高电平时，禁止RO输出并将RO置为高阻态。   |
| 3                       | —                       | —                       | DE                         | 驱动器输出使能。驱动DE为低电平时将驱动器输出置为三态；驱动DE为高电平时使能驱动器。  |
| 4                       | 4                       | 4                       | DI                         | 驱动器输入。驱动DI为低电平时，拉低同相输出并拉高反相输出；驱动DI为高电平时，拉高同相输出并拉低反相输出。DI是内部状态机的一个输入端，该状态机自动使能和禁止驱动器(MAX13412E/MAX13413E)，更多信息请参考功能表和概述。                        |
| 5                       | 5                       | 5                       | GND                        | 地。   |
| 6                       | 6                       | 6                       | A                          | 接收器同相输入端和驱动器同相输出端。   |
| 7                       | 7                       | 7                       | B                          | 接收器反相输入端和驱动器反相输出端。   |
| 8                       | 8                       | 8                       | V <sub>CC</sub>            | 正电源，用一个0.1 $\mu\text{F}$ 的陶瓷电容将V <sub>CC</sub> 旁路至GND。   |
| —                       | 1                       | —                       | RO                         | 接收器输出。接收器使能时，如果 $V_A - V_B \geq -100\text{mV}$ ，RO为高电平；如果 $V_A - V_B \leq -100\text{mV}$ ，则RO为低电平。 <b>注意：</b> RO以LDO输出( $V_{\text{REG}}$ )为参考。 |
| —                       | 2                       | —                       | $\overline{\text{RE}}$     | 接收器输出使能。驱动 $\overline{\text{RE}}$ 为低电平使能RO输出；驱动 $\overline{\text{RE}}$ 为高电平时，将由AutoDirection电路控制RO。  |
| —                       | 3                       | 3                       | V <sub>REG</sub>           | LDO输出，V <sub>REG</sub> 固定为+5V。用一个低ESR (20m $\Omega$ 或更低)的1 $\mu\text{F}$ (最小值)陶瓷电容旁路V <sub>REG</sub> 。   |
| —                       | —                       | 2                       | DE/ $\overline{\text{RE}}$ | 接收器和驱动器输出使能，驱动DE/ $\overline{\text{RE}}$ 为低电平将使能RO并禁止驱动器工作；驱动DE/ $\overline{\text{RE}}$ 为高电平则禁止RO输出并使能驱动器。                                     |
| EP                      | EP                      | EP                      | EP                         | 裸焊盘，EP在内部连接至GND。为增强散热能力，须将EP连接至尽可能大的覆铜区。请勿将EP作为唯一的接地端。   |

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

MAX13410E-MAX13415E

MAX13410E/MAX13411E功能表

| TRANSMITTING    |    |    |                           |                |
|-----------------|----|----|---------------------------|----------------|
| INPUT           |    |    | OUTPUT                    |                |
| $\overline{RE}$ | DE | DI | B                         | A              |
| X               | 1  | 1  | 0                         | 1              |
| X               | 1  | 0  | 1                         | 0              |
| 0               | 0  | X  | High impedance            | High impedance |
| 1               | 0  | X  | High impedance (shutdown) |                |

| RECEIVING       |    |               |                           |
|-----------------|----|---------------|---------------------------|
| INPUT           |    |               | OUTPUT                    |
| $\overline{RE}$ | DE | A - B         | RO                        |
| 0               | X  | $\geq -50mV$  | 1                         |
| 0               | X  | $\leq -200mV$ | 0                         |
| 0               | X  | Open/Short    | 1                         |
| 1               | 1  | X             | High impedance            |
| 1               | 0  | X             | High impedance (shutdown) |

X = 无关。关断模式下，驱动器和接收器输出为高阻态。

MAX13412E/MAX13413E功能表

| TRANSMITTING |                  |                                |                |                |
|--------------|------------------|--------------------------------|----------------|----------------|
| INPUTS       |                  |                                | OUTPUTS        |                |
| DI           | A - B > $V_{DT}$ | ACTION                         | A              | B              |
| 0            | X                | Turn driver ON                 | 0              | 1              |
| 1            | False            | If driver was OFF, keep it OFF | High impedance | High impedance |
| 1            | False            | If driver was ON, keep it ON   | 1              | 0              |
| 1            | True             | Turn driver OFF                | High impedance | High impedance |

| RECEIVING       |               |              |                |                |
|-----------------|---------------|--------------|----------------|----------------|
| INPUTS          |               |              | OUTPUT         |                |
| $\overline{RE}$ | A - B         | DRIVER STATE | RECEIVER STATE | RO             |
| 0               | $\geq -100mV$ | X            | ON             | 1              |
| 0               | $\leq -100mV$ | X            | ON             | 0              |
| 1               | X             | ON           | OFF            | High impedance |
| 1               | $\geq -100mV$ | OFF          | ON             | 1              |
| 1               | $\leq -100mV$ | OFF          | ON             | 0              |

X = 无关。关断模式下，驱动器和接收器输出为高阻态。

MAX13414E/MAX13415E功能表

| TRANSMITTING        |    |                |                |
|---------------------|----|----------------|----------------|
| INPUT               |    | OUTPUT         |                |
| DE/ $\overline{RE}$ | DI | B              | A              |
| 0                   | X  | High impedance | High impedance |
| 1                   | 1  | 0              | 1              |
| 1                   | 0  | 1              | 0              |

| RECEIVING           |               |                |
|---------------------|---------------|----------------|
| INPUT               |               | OUTPUT         |
| DE/ $\overline{RE}$ | A - B         | RO             |
| 0                   | $\geq -50mV$  | 1              |
| 0                   | $\leq -200mV$ | 0              |
| 0                   | Open/Short    | 1              |
| 1                   | X             | High impedance |

X = 无关。关断模式下，驱动器和接收器输出为高阻态。

# RS-485收发器，集成低压差稳压器和AutoDirection控制

## 详细说明

MAX13410E-MAX13415E为半双工RS-485/RS-422兼容收发器，针对隔离应用进行了优化。这些器件具有内部LDO稳压器、驱动器和接收器。内部LDO允许器件采用+6V至+28V的非稳压电源供电。AutoDirection功能可减少隔离应用中的光电耦合器数量。其它特性包括±15kV ESD保护(MAX13412E/MAX13413E)、±14kV ESD保护(MAX13410E/MAX13411E)并具有失效保护和摆率限制，可全速运行。

MAX13410E-MAX13415E的内部LDO产生一路5V ±10%的电源电压，为内部电路供电。MAX13412E-MAX13415E将5V提供给输出端V<sub>REG</sub>，允许用户为其它外部电路提供20mA的供电，进一步减少外部元件。MAX13410E/MAX13411E不具备5V输出，提供工业标准的引脚排列，可以方便地替代现有设计。

MAX13412E/MAX13413E采用Maxim专有的AutoDirection控制技术，该结构省去了DE和 $\overline{RE}$ 控制信号。在隔离应用中，能够减少光电耦合器，从而降低系统的成本和尺寸。

MAX13410E/MAX13412E/MAX13414E具有有限摆率驱动器，可有效降低EMI，并降低由于不恰当的电缆端接所导致的反射，能够无差错地以500kbps传输数据。MAX13411E/MAX13413E/MAX13415E不带摆率限制，传输速率可达16Mbps。

MAX13410E-MAX13415E具有1/8单位负载的接收器输入阻抗，允许在一条总线上挂接256个收发器。所有驱动器输出都具有人体模式的±15kV ESD保护。这些器件(MAX13410E/MAX13411E/MAX13414E/MAX13415E)还具有失效保护电路，可在接收器输入开路或短路时保证输出逻辑高电平。当端接总线的发送器被禁止时(高阻态)，接收器输出逻辑高电平。

## 内部低压差稳压器

MAX13410E-MAX13415E包括一个内部低压差稳压器，允许采用高达+28V的输入电压供电。内部LDO具有预设的5V ±10%输出，为器件的内部电路供电。MAX13412E-MAX13415E将LDO输出提供给V<sub>REG</sub>输出端，允许为其它外部电路供电，无需额外的外部稳压器。V<sub>REG</sub>输出可以提供高达20mA的电流。

在高输入电压和重载时使用这些器件时，必须注意不要超出封装能够耗散的额定功率和器件的最高管芯温度。可以使用下式计算器件的管芯温度：

$T_{DIE} = [(\theta_{JC} + \theta_{CA}) \times P_{DISS}] + T_{AMBIENT}$ ，其中

$T_{DIE}$  = 管芯温度

$\theta_{JC}$  = 6.0°C/W = 结至封装的热阻

$\theta_{CA}$  = 封装至环境的热阻

$\theta_{JA} = \theta_{JC} + \theta_{CA} = 52.0^\circ\text{C/W}$  = 结至环境的热阻

$P_{DISS} = (I_{CC} - V_{CC}) + [(V_{CC} - V_{REG}) \times I_{REG}] + [(V_{CC} - V_{OD}) \times I_{DRIVER}]$  = 器件功耗

$T_{AMBIENT}$  = 环境温度

$V_{CC}$  = V<sub>CC</sub>输入端电压

$I_{CC}$  = V<sub>CC</sub>输入端电流

$V_{REG}$  = V<sub>REG</sub>输出电压

$I_{REG}$  = 从V<sub>REG</sub>输出汲取的电流

$V_{OD}$  = 驱动器输出电压(V<sub>A</sub> - V<sub>B</sub>)

$I_{DRIVER}$  = 驱动器输出电流，通常为流过端接电阻的电流

MAX13410E-MAX13415E的管芯温度额定值为+150°C。为防止器件过热，在管芯温度达到+150°C时，内部热关断电路将关闭器件。为了避免损坏器件并防止器件进入热关断模式，应保持管芯温度低于+150°C，并留出一定裕量。电路设计者可以通过控制以下参数使管芯温度最低：

- V<sub>CC</sub>
- I<sub>REG</sub>
- $\theta_{CA}$

## 测量V<sub>CC</sub>电流

V<sub>CC</sub>引脚测量到的电流是以下参数的函数：器件静态电流、驱动器供给负载的电流；对于MAX13412E-MAX13415E来说，还包括V<sub>REG</sub>输出端的负载电流。大多数情况下，驱动器必须带动的负载是端接电阻。理想条件下，端接电阻与传输线的特性阻抗相匹配，设计人员不能轻易地更改这个参数。在一些低速、传输电缆较短的应用中，无需端接电阻。这种情况下可以降低驱动器电流，从而使管芯温度最低。

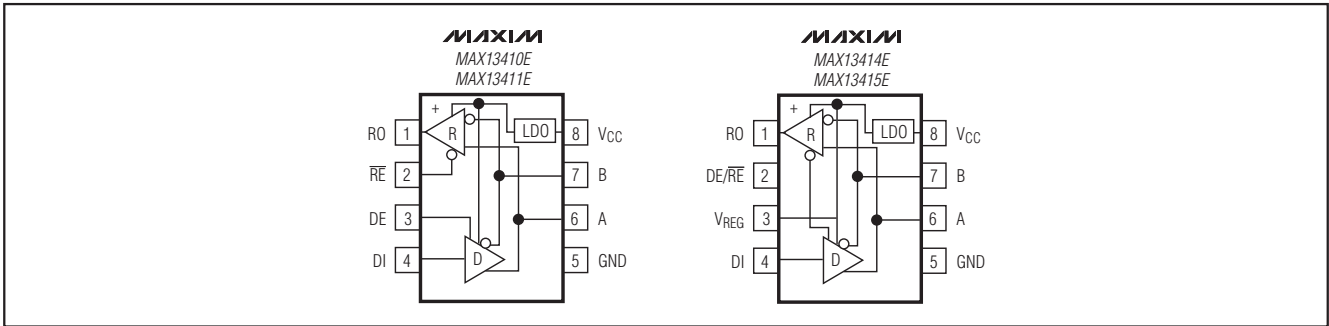
减小V<sub>REG</sub>输出端的负载会降低器件的功耗，最终降低最大管芯温度。



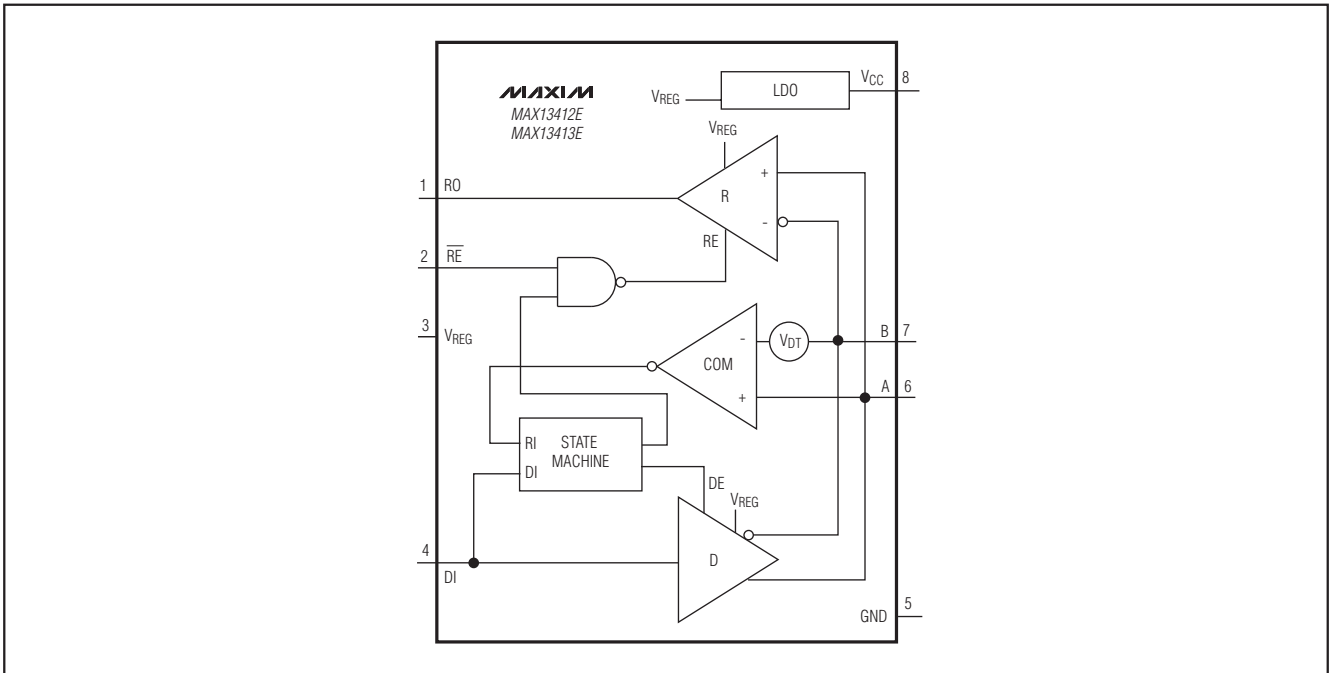
# RS-485收发器，集成低压差稳压器和AutoDirection控制

功能框图

MAX13410E/MAX13411E/MAX13414E/MAX13415E的功能框图



MAX13412E/MAX13413E的功能框图



$\theta_{CA}$ 是封装至环境的热阻，与MAX13410E-MAX13415E无关。 $\theta_{CA}$ 主要取决于电路板设计，对 $\theta_{CA}$ 影响最大的因素是连接至MAX13410E-MAX13415E裸焊盘的覆铜尺寸和厚度。使用尽可能大的焊盘可使热阻更低。另外，过孔可用于将焊盘连接至电路板的其它地层。

注意 $\theta_{JC}$ 是器件结至封装的热阻，固定为6.0°C/W，由MAX13410E-MAX13415E的管芯与封装特性确定，电路设计者无法控制该参数。

MAX13410E-MAX13415E

# RS-485收发器，集成低压差稳压器和AutoDirection控制

## 失效保护

当接收器输入短路或开路，或将接收器连接到所有驱动器都被禁止的端接传输线时，MAX13410E/MAX13411E/MAX13414E/MAX13415E能够保证接收器输出逻辑高电平，这一功能通过将接收器输入门限设置为-50mV和-200mV实现。如果接收器的差分输入电压(A - B)大于或等于-50mV，RO为逻辑高电平；如果(A - B)小于或等于-200mV，RO为逻辑低电平。对于所有发送器都处于禁止状态的端接总线，接收器的差分输入电压被端接电阻拉至0电位，按照MAX13410E/MAX13411E/MAX13414E/MAX13415E的接收器门限，输出为逻辑高电平，并具有最低50mV的噪声容限。与传统的失效保护器件不同，-50mV至-200mV的门限兼容于±200mV的EIA/TIA-485标准。

## AutoDirection电路

MAX13412E/MAX13413E中的AutoDirection电路能够使器件驱动信号的数量最少，非常适合对成本要求苛刻的隔离系统。在典型的隔离系统中，每路跨越隔离栅的控制信号都需要一个光耦。这些光耦会增加系统的成本、尺寸和功耗。没有AutoDirection电路时，每个收发器都需要3至4个光耦；利用AutoDirection电路可以使光耦数减少至2个。

典型的RS-485收发器控制侧具有4路信号，分别是：RO（接收器输出）、 $\overline{RE}$ （接收器使能）、DE（驱动器使能）、DI（驱动器输入）。某些情况下，DE和 $\overline{RE}$ 可以连接在一起将控制信号减少到3路。在半双工系统中， $\overline{RE}$ 和DE信号决定器件的发送或接收状态。器件处于接收时，发送器为高阻态。在完全兼容的RS-485系统中，需要3路或4路信号。但是，经过精心设计并配合Maxim的AutoDirection功能，RS-485兼容系统的控制信号可以减少到只需要RO和DI。该功能假设在MAX13412E/MAX13413E的接收器电路工作时，DI输入的空闲状态为高电平。这还需要在A线加一个外部上拉电阻，B线加一个外部下拉电阻(请参考典型应用电路，图10)，以下介绍AutoDirection的工作原理。

当DI为低电平时，MAX13412E/MAX13413E将总线驱动到低电平；当DI从低电平跳变到高电平时，驱动器在(A - B)

>  $V_{DT}$ 之前有效驱动输出；一旦(A - B)大于 $V_{DT}$ ，驱动器将禁止工作，由上拉/下拉电阻保持A、B线处于正确的状态，从而允许总线上的其它发送器拉低总线。

## 上拉和下拉电阻

对于MAX13412E和MAX13413E，为保证正常工作，A、B线上必需加上拉和下拉电阻，但电阻值要求并不严格。它们的功能是在所有发送器因关断状态或AutoDirection而处于高阻态时，保持总线为高电平(A - B > 200mV)。确定这些电阻的最佳值取决于多种因素，例如端接电阻、噪声、总线接收器的数量等。合理选择这些电阻，能够确保在任何条件下为所有总线接收器提供(A - B) > 200mV。

## 空闲状态

没有数据传输时，MAX13412E/MAX13413E要求DI输入驱动至高电平，保持闲置状态。传统的RS-485收发器具有DE和 $\overline{RE}$ 输入，用于使能和禁止驱动器、接收器。而MAX13412E/MAX13413E不具有DE输入，而是利用内部状态机使能、禁止驱动器。进入空闲状态时，DI必须驱动至高电平。

## 增强型ESD保护

与Maxim的其它器件一样，该系列器件的所有引脚都提供ESD保护电路，在对器件操作和装配过程中出现静电放电时能够提供有效保护。MAX13410E-MAX13415E系列产品的驱动器输出与接收器输入具有额外的静电保护能力。Maxim的工程师开发出了目前技术水平最高的电路结构，为这些引脚提供保护，使其能够承受±15kV (MAX13412E/MAX13413E)和±14kV (MAX13410E/MAX13411E)的ESD冲击。ESD保护结构在任何状态下都可承受较高的ESD冲击，包括标准工作模式、关断和断电模式。受到ESD冲击后，MAX13410E-MAX13415E能够继续工作而不会闭锁或损坏。

ESD保护可以采用不同方法进行测试，MAX13410E-MAX13415E的发送器输出与接收器输入在以下条件下进行了保护测试：

±15kV，人体模式(MAX13412E/MAX13413E)

±14kV，人体模式(MAX13410E/MAX13411E)

## RS-485收发器，集成低压差稳压器和AutoDirection控制

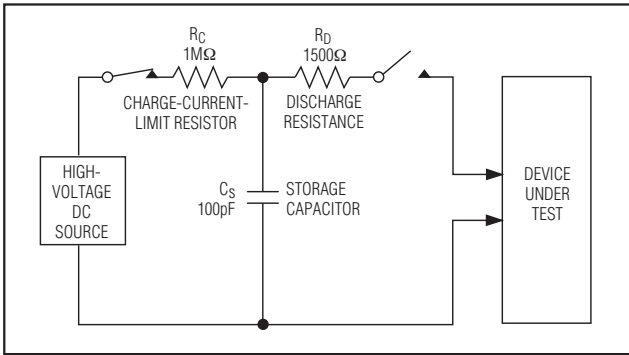


图8a. 人体模式ESD测试模型

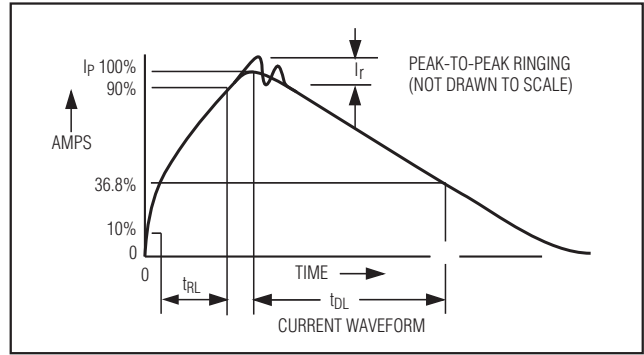


图8b. 人体模式下的电流波形

### ESD测试条件

ESD性能取决于多种条件，如果需要包括测试条件、测试方法和结果在内的可靠性报告，请与Maxim联系。

### 人体模式

图8a所示为人体模式，对低阻放电时产生的电流波形如图8b所示。该模型包括一个100pF电容，先将其充电至所要求的ESD电压，然后通过1.5kΩ电阻向被测器件放电。

## 应用信息

### 典型应用

MAX13410E-MAX13415E收发器设计用于多点总线传输线的半双工、双向数据通信。为减小反射，应当在传输线两端以其特性阻抗进行终端匹配，主干线以外的分支连线长度应尽可能短。具有摆率限制的MAX13410E/MAX13412E/MAX13414E对不良终端匹配具有较高容忍。

### MAX13410E和MAX13411E的典型应用电路

典型应用电路给出了MAX13410E/MAX13411E的隔离应用电路(图9所示)。MAX13410E/MAX13411E采用工业标准的引脚排列，不具有为外部电路提供偏置的 $V_{REG}$ 输出。按照设计要求，可选择在RS-485输出安装正温度系数(PTC)电阻和瞬变电压抑制器(TVS)，用于电压钳位，以提供过压故障保护。

### MAX13412E和MAX13413E的典型应用电路

典型应用电路给出了MAX13412E/MAX13413E的隔离应用电路，利用AutoDirection功能将光耦数量减少到2个(图10所示)。MAX13412E/MAX13413E提供 $V_{REG}$ 输出，可为外部电路提供20mA电流。

### MAX13414E和MAX13415E的典型应用电路

典型应用电路给出了MAX13414E/MAX13415E的隔离应用电路，采用非稳压电源供电，电路中使用3个光耦(图11所示)。MAX13414E/MAX13415E提供 $V_{REG}$ 输出，可为外部电路提供20mA电流。

### 总线上挂接256个收发器

RS-485标准规定的总线上每个接收器的电阻称为单位负载。当使用两端以120Ω端接的电缆时，RS-485标准要求驱动器能够在-7V至+12V共模电压范围内驱动32个单位负载的接收器。MAX13410E-MAX13415E具有1/8单位负载，这意味着一个标准兼容的发送器可以驱动多达256个MAX13410E-MAX13415E器件。减小共模范围和/或改变电缆的特性阻抗，可以使用更多数量的接收器，详细信息请参考TIA/EIA-485规范。

# RS-485收发器，集成低压差稳压器和AutoDirection控制

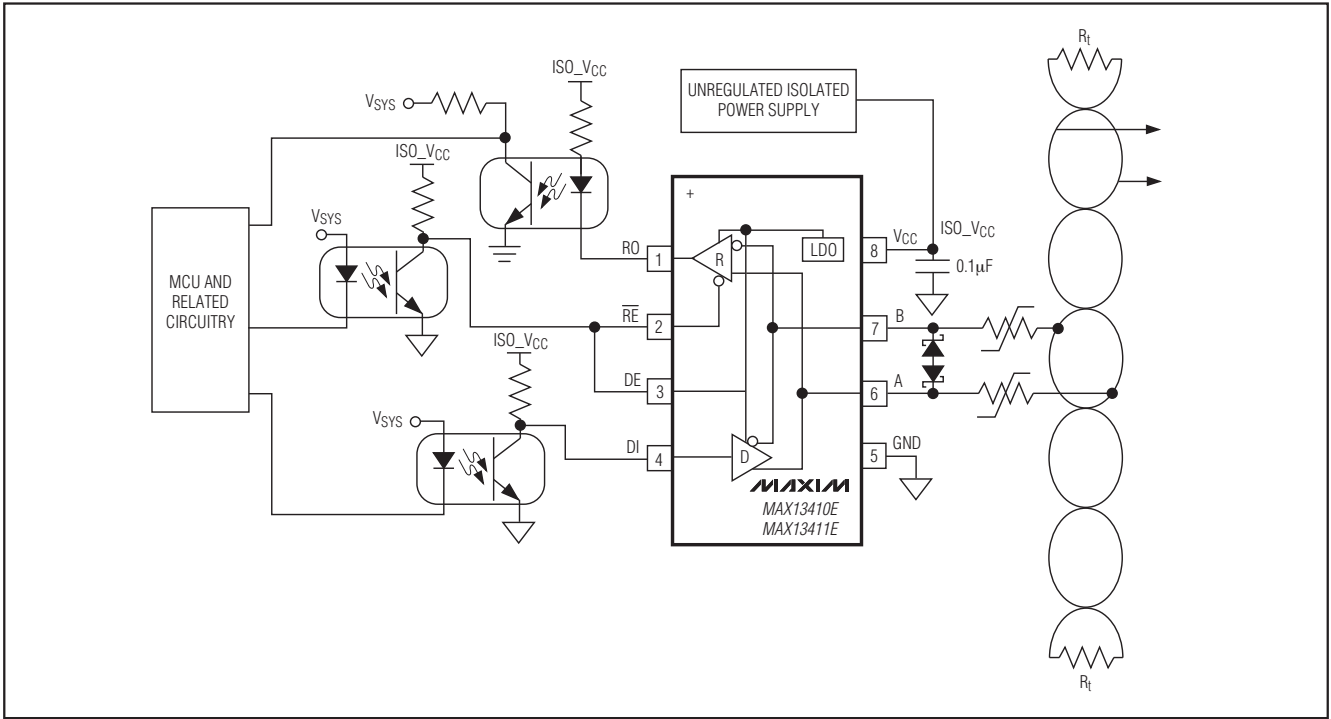


图9. MAX13410E/MAX13411E的典型应用电路

## 正确的端接和电缆/连线配置

当RS-485的数据速率相对于驱动电缆的长度较高时，系统必须采用正确的端接设计。大多数情况下，应该使用一条阻抗受控的电缆或总线，并在传输线两端采用阻值等于电缆/总线特性阻抗的电阻进行端接。RS-485收发器必须以最短的传输线连接到电缆/总线，以防止反射。星形连接和不恰当的端接电缆会导致数据丢失，详细信息请参考Maxim网站的应用笔记部分或TIA/EIA文献TSB-89-A。通常都希望总线进行恰当的端接，但在某些情况下，例如数据速率非常低时，不对电缆进行端接可能更方便。这种情况下，需要设计者确保不恰当的端接导致的反射(等)不会导致数据出错。

## 降低EMI和反射

MAX13410E/MAX13412E/MAX13414E的限摆率驱动器可以减小EMI，并降低由于不恰当的终端匹配电缆引起的反射，允许高达500kbps的无差错数据传输。

## 低功耗关断模式

DE接低电平、 $\overline{RE}$ 接高电平时，使MAX13410E/MAX13411E进入低功耗关断模式。关断模式下，器件仅吸收65 $\mu$ A(典型值)的电源电流。

若DE为低电平(而 $\overline{RE}$ 为高电平)的持续时间小于50ns，器件可以确保不进入关断模式。如果输入端维持这种状态700ns以上，器件可确保进入关断模式。

使能时间 $t_{ZH}$ 与 $t_{ZL}$ (见Switching Characteristics表)假定器件并未处于低功耗关断状态；使能时间 $t_{ZH(SHDN)}$ 与 $t_{ZL(SHDN)}$ 假定器件处于关断状态。从低功耗关断模式到驱动器、接收器转变到有效状态所需要的时间( $t_{ZH(SHDN)}$ 、 $t_{ZL(SHDN)}$ )，要比从禁止模式下转变为有效状态所需要的时间( $t_{ZH}$ 、 $t_{ZL}$ )长。

## 传输线长度

电信工业协会(TIA)发布的TSB-89-A: *Application Guidelines for TIA/EIA-485-A*为确定最高数据速率与传输线长度的关系提供了一个很好的参考。

# RS-485收发器，集成低压差稳压器和AutoDirection控制

MAX13410E-MAX13415E

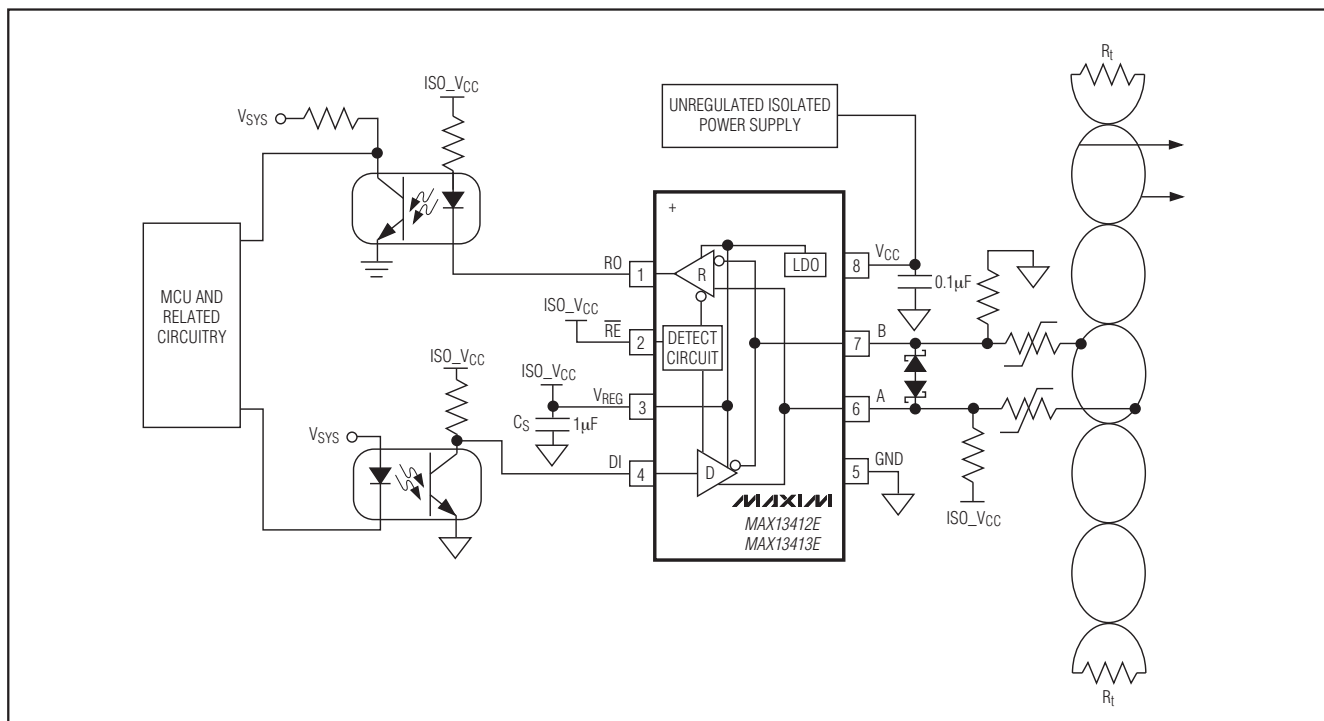


图10. MAX13412E/MAX13413E的典型应用电路

## 隔离型RS-485接口

隔离型RS-485接口可将总线上的不同节点进行电气隔离，能够解决高共模电压(共模电压超出RS-485共模电压范围)、传导噪声以及环路接地问题。典型应用电路给出了用MAX13410E-MAX13415E构成的隔离型RS-485接口。收发器与控制电路电源相隔离。MAX13412E/MAX13413E的AutoDirection功能(见AutoDirection电路部分)仅需两个光耦即可实现收发器的电气隔离。

隔离型RS-485接口可将总线上的不同节点进行电气隔离，能够解决高共模电压(共模电压超出RS-485共模电压范围)问题。隔离型RS-485接口设计通常面临两个与RS-485无关的挑战，即1)隔离控制信号和2)收发器隔离供电。光耦是将控制信号传过隔离栅的常用方法。

隔离电源通常使用推挽或反激配置的变压器。MAX845是一款廉价的非稳压型推挽式转换器(见图12)。理论上非稳

压型推挽转换器的输出是预知的，输出电压会由于变压器的非理想特性、负载变化和二极管的温度漂移出现明显的变化，有时会出现±20%或更大的变化量。这时，需要增加一个线性稳压器来保证标准RS-485收发器的工作。既然MAX13410E-MAX13415E具有内部线性稳压器，即可省去与外部稳压器相关的成本和尺寸。具有±20%误差的+7.5V标称电源具有+6V至+9V供电电压范围，恰好位于MAX13410E-MAX13415E的工作范围内。如果输出误差大于±20%，请将电源的输出电压调整至较高值，以确保满足最低输入电压的要求。

反激转换器通常为稳压型，常用一个类似于TL431的误差放大器和光耦组成环路。MAX5021是一款小尺寸、廉价的反激控制器(见图13)。反激转换器的原边输出很稳定，但副边输出可能不稳定。对于非稳压、推挽式转换器，MAX13410E-MAX13415E能够非常理想地工作在副边输出供电的情况下。

# RS-485收发器，集成低压差稳压器和AutoDirection控制

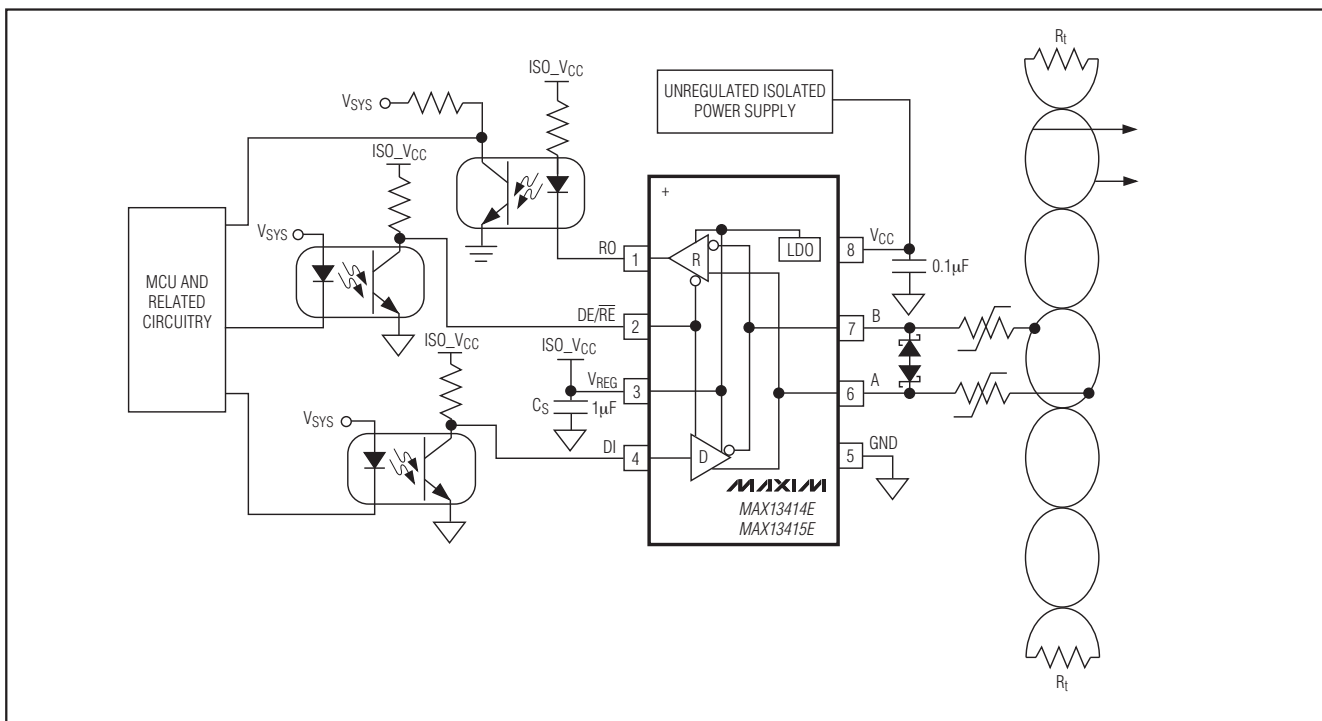


图11. MAX13414E/MAX13415E的典型应用电路

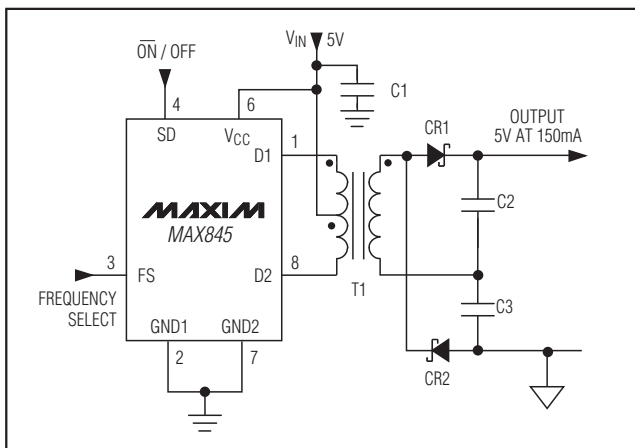


图12. 利用MAX845提供隔离供电

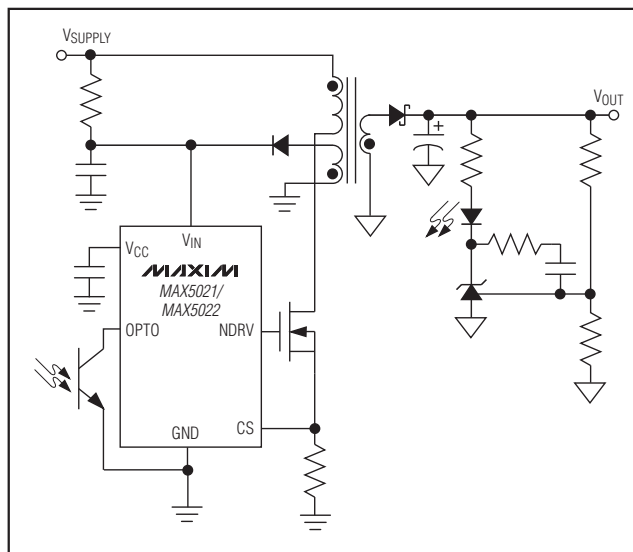
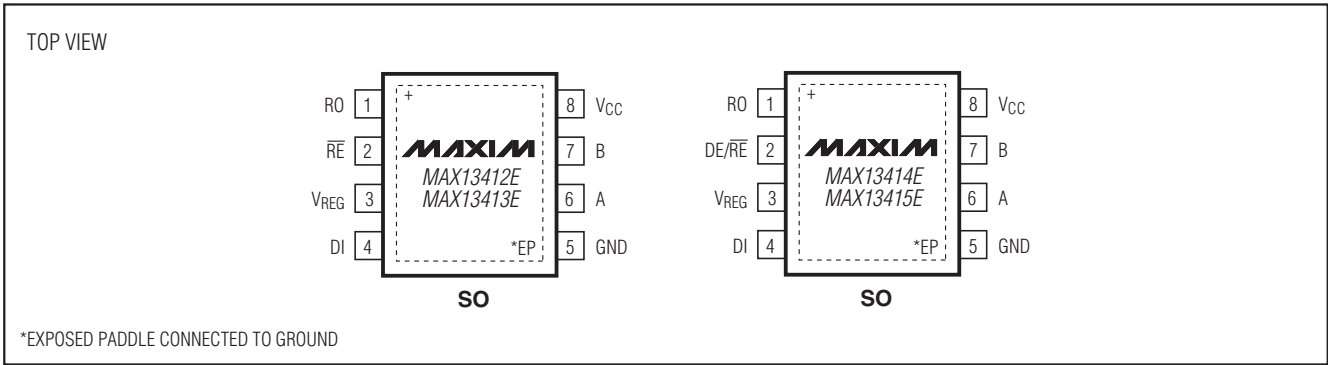


图13. 反馈采用光耦，MAX5021和MAX5022提供非常稳定的隔离电源

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

引脚配置(续)



订购信息/选型指南(续)

| PART            | PIN-PACKAGE | AutoDirection | DATA RATE (max) | SLEW-RATE LIMITED | PKG CODE |
|-----------------|-------------|---------------|-----------------|-------------------|----------|
| MAX13412EESA+   | 8 SO-EP*    | Yes           | 500kbps         | Yes               | S8E+14   |
| MAX13413EESA+   | 8 SO-EP*    | Yes           | 16Mbps          | No                | S8E+14   |
| MAX13414EESA+** | 8 SO-EP*    | No            | 500kbps         | Yes               | S8E+14   |
| MAX13415EESA+** | 8 SO-EP*    | No            | 16Mbps          | No                | S8E+14   |

注：所有器件工作于-40°C至+85°C温度范围。  
+表示无铅封装。

\*EP = 裸焊盘。  
\*\*未来产品——供货状况请联络厂方。

芯片信息

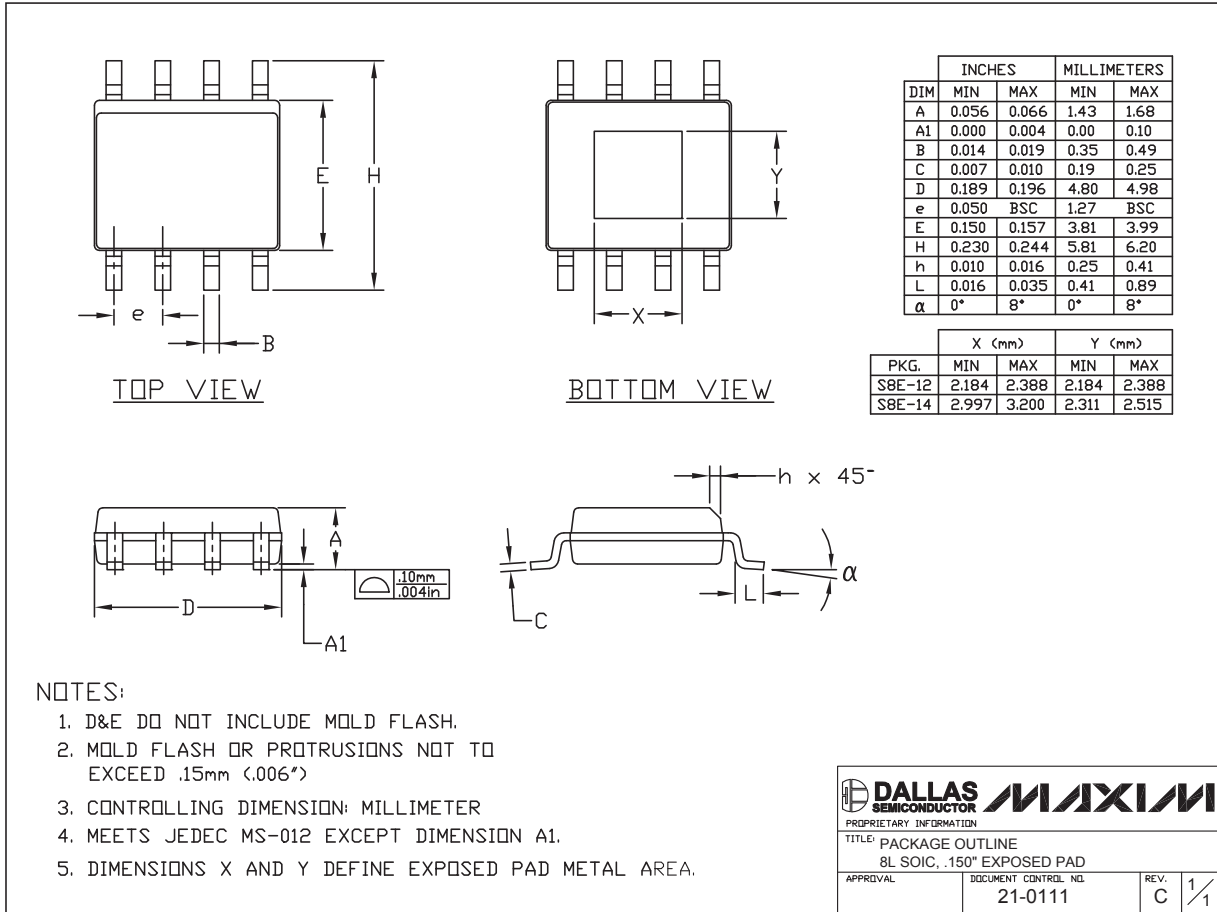
PROCESS TECHNOLOGY: BiCMOS

MAX13410E-MAX13415E

# RS-485收发器，集成低压差稳压器 和AutoDirection控制

封装信息

(本数据资料提供的封装图可能不是最近的规格，如需最近的封装外形信息，请查询 [www.maxim-ic.com.cn/packages](http://www.maxim-ic.com.cn/packages).)



## Maxim北京办事处

北京 8328信箱 邮政编码 100083

免费电话: 800 810 0310

电话: 010-6211 5199

传真: 010-6211 5299

Maxim不对Maxim产品以外的任何电路使用负责，也不提供其专利许可。Maxim保留在任何时间、没有任何通报的前提下修改产品资料和规格的权利。

24 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600