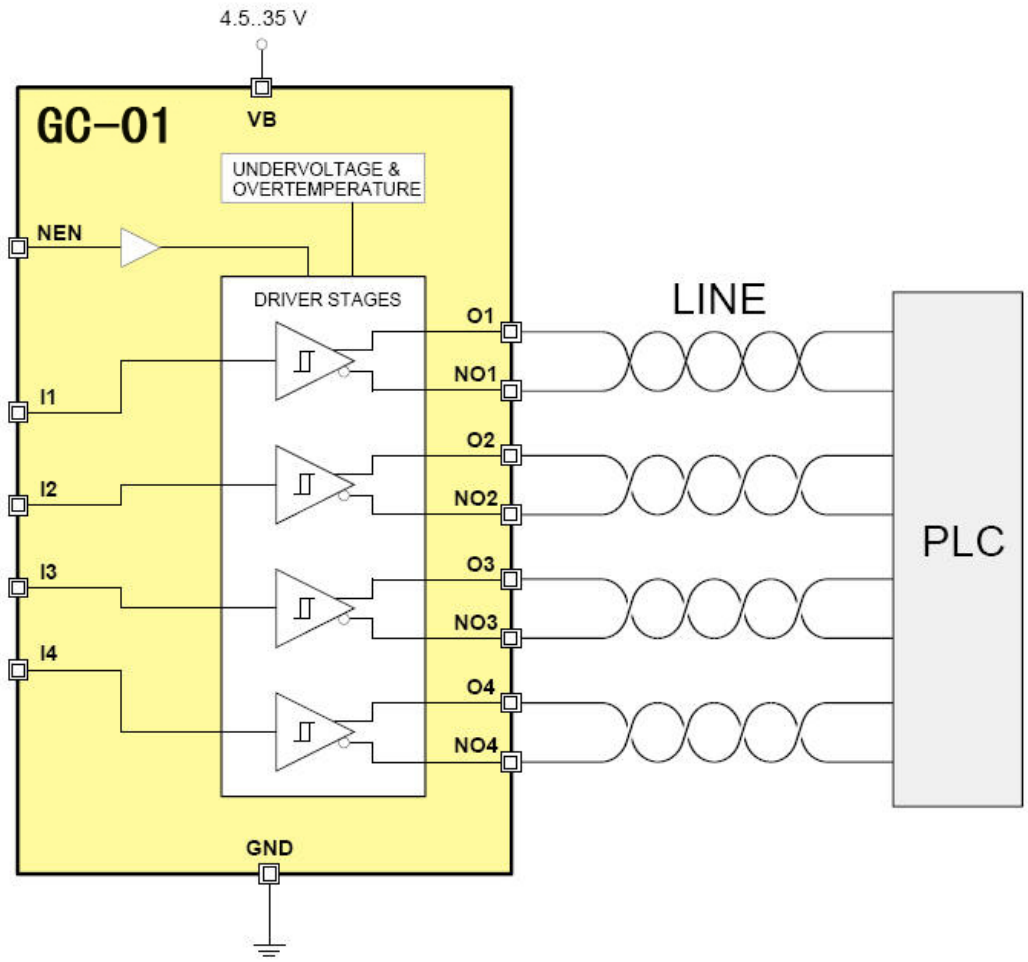
**FEATURES**

- Complementary short-circuit-proof push-pull driver stages for RS422 and 24 V applications up to 2 MHz
- Pin-compatible to 26LS31, xx7272
- Integrated line adaptation for high signal quality at 24 V
- Moderate slew rate reduces EMI
- High driving capability of typically 200 mA at 24 V
- Output saturation of just 0.3 V at 40 mAdc
- Tristate function for bus applications with excessive temperature shutdown
- TTL-/CMOS-compatible Schmitt trigger inputs, voltage-proof to 40 V
- 4.5 to 35 V single supply operation with low static power dissipation
- Operating temperature from -25 to 125 °C (-40 °C is optional)

**APPLICATIONS**

- Line drivers for 24 V control engineering
- Linear scales and encoders
- Sensor systems

**BLOCK DIAGRAM**



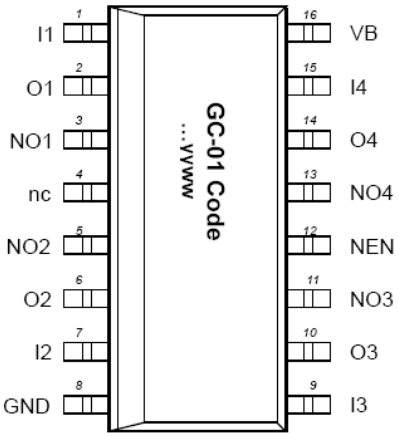

**DESCRIPTION**

- GC-01 is a robust line driver for industrial 5 V and 24 V Applications with four complementary output channels.

- For signal lines with a characteristic impedance of 30 to 140 Ω the integrated line adapter, optimized to 75 Ω, minimizes ringing effects which arise when there is no line termination.
- At a supply of 24 V the push-pull driver stages typically provide 200 mA to discharge the line and also have a low saturation voltage (of typically 200 mV with a 40 mA low-side load). The outputs are current limited and short-circuit-proof, shutting down with excessive temperature.
- For bus applications the driver stages can be switched to high impedance by a high at input NEN.
- The driver stage inputs have a Schmitt trigger characteristic and are compatible with CMOS and TTL levels.
- For test purposes the temperature monitor can be deactivated by applying a voltage of greater than 12 V to input NEN.
- GC-01 contains internal ESD protection circuitry.

## PACKAGES SO16N


### PIN CONFIGURATION SO16N




### PIN FUNCTIONS

| No. | Name | Function |
|---|---|---|
| 1 | I1 | Input 1 |
| 2 | O1 | Driver Output 1 |
| 3 | NO1 | Inverted Driver Output 1 |
| 4 | nc | |
| 5 | NO2 | Inverted Driver Output 2 |
| 6 | O2 | Driver Output 2 |
| 7 | I2 | Input 2 |
| 8 | GND | Ground |
| 9 | I3 | Input 3 |
| 10 | O3 | Driver Output 3 |
| 11 | NO3 | Inverted Driver Output 3 |
| 12 | NEN | Function Input (low signal enables driver outputs) |
| 13 | NO4 | Inverted Driver Output 4 |
| 14 | O4 | Driver Output 4 |
| 15 | I4 | Input 4 |
| 16 | VB | +4.5 to +35 V Supply Voltage |

## ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed. Absolute Maximum Ratings are no Operating Conditions. Integrated circuits with system interfaces, e.g. via cable accessible pins (I/O pins, line drivers) are per principle endangered by injected interferences, which may compromise the function or durability. The robustness of the devices has to be verified by the user during system development with regards to applying standards and ensured where necessary by additional protective circuitry. By the manufacturer

suggested protective circuitry is for information only and given without responsibility and has to be verified within the actual system with respect to actual interferences.

| Item No. | Symbol | Parameter | Conditions | Min. | Max. | Unit |
|---|---|---|---|---|---|---|
| G001 | VB | Supply Voltage VB | | 0 | 40 | V |
| G002 | Vin() | Voltage at Inputs I1...I4 | | 0 | VB | V |
| G003 | Vin() | Voltage at Input NEN | | 0 | VB | V |
| G004 | V() | Voltage at Outputs O1...O4, NO1...NO4 | | 0 | VB | V |
| G005 | I() | Current in Outputs O1...O4, NO1...NO4 | | -500 | 500 | mA |
| G006 | Vd() | ESD Susceptibility at all pins | HBM, 100 pF discharged through 1.5 kΩ | | 2 | kV |
| G007 | Tj | Junction Temperature | | -40 | 150 | °C |
| G008 | Ts | Storage Temperature | | -40 | 150 | °C |

## THERMAL DATA

| Item No. | Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| T01 | Ta | Operating Ambient Temperature | | -25 | | 125 | °C |
| T02 | Rthja | Thermal Resistance Chip To Ambient | SO16N surface mounted, no special heat sink | | 110 | | K/W |

All voltages are referenced to ground unless otherwise stated.
All currents into the device pins are positive; all currents out of the device pins are negative.

## ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 4.5...35 V, Tj = -40...125 °C, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **Total Device** | | | | | | | |
| 001 | VB | Permissible Supply Voltage | | 4.5 | | 35 | V |
| 002 | I(VB) | Supply Current in VB | NEN = lo, outputs not loaded | | 3.8 | 5.5 | mA |
| 003 | I(VB)tri | Tristate Current Consumption in VB | NEN = hi | | 2.7 | | mA |
| 004 | Vc()lo | Clamp Voltage lo at | I() = -1 mA | -1.2 | | -0.3 | V |
| 005 | Vc()hi | Clamp Voltage hi at | I() = 1 mA | VB + | | VB + | V |
| 006 | Vc()lo | Clamp Voltage lo at O1..O4, NO1..NO4 | VB = 0 V, I() = -10 mA | -1.2 | | -0.3 | |
| 007 | Vc()hi | Clamp Voltage hi at O1..O4, NO1..NO4 | VB = 0 V, I() = 10 mA | VB + | | VB + | |
| **Driver Outputs Ox, NOx (x = 1...4)** | | | | | | | |
| 101 | Vs()lo | Saturation Voltage lo | I() = 40 mA | | 0.2 | 0.6 | V |
| 102 | Vs()hi | Saturation Voltage hi | Vs()hi = VB - V(); I() = -40 mA | | 0.3 | 0.7 | V |
| 103 | Iout()lo | Driving Capability lo | VB = 30 V, V() = 3 V | 40 | 60 | 90 | mA |
| 104 | Iout()hi | Driving Capability hi | VB = 30 V, V() = VB − 3 V | -90 | -60 | -40 | mA |
| 105 | Isc()lo | Short-Circuit Current lo | VB = 30 V, V() = VB | | | 500 | mA |
| 106 | Isc()hi | Short-Circuit Current hi | V() = 0 V | -500 | | | mA |
| 107 | Rout() | Output Resistance | VB = 10...30 V, V() = VB/2 | 50 | 75 | 110 | Ω |
| 108 | SR()lo, hi | Slew-Rate lo/hi | VB = 24 V, CL = 100 pF | | 400 | | V/µs |
| 109 | tp()lo, hi | In/Out Propagation Delay lo/hi | | | 75 | 200 | ns |
| 110 | dtp() | Delay Skew | output Ox vs. NOx | -35 | | 35 | ns |
| 111 | Ilk() | Output Leakage Current | NEN = hi | -10 | | 10 | uA |
| **Driver Inputs Ix (x=1...4)** Functional input voltage range V(Ix) = 0 to 7.5V | | | | | | | |
| 201 | Vt()lo | Threshold Voltage lo | | 0.8 | | | V |
| 202 | Vt()hi | Threshold Voltage hi | | | | 2.4 | V |
| 203 | Vt()hys | Input Hysteresis | | 0.1 | 0.2 | | V |
| 204 | I() | Input Leakage Current | 0 V < V() < VREF | -5 | | 5 | µA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Function Input NEN** | | | | | | | |
| 301 | Vt1()lo | Threshold Voltage lo | Driver enabled for | 0.8 | | | V |
| 302 | Vt1()hi | Threshold Voltage hi | | | | 2.4 | V |
| 303 | Vt1()hys | Input Hysteresis | | 0.1 | 0.2 | | V |
| 304 | Vt2()hi | Threshold Voltage hi | Driver enabled without thermal shutdown function for V(NEN) > Vt2()hi | 7.5 | 10 | 12 | V |
| 305 | Vt2()hys | Input Hysteresis | | | 0.5 | | V |
| 306 | Iin() | Input Current | 5 V < V(NEN) < VB | | 100 | 400 | µA |
| 307 | Iin() | Input Current | 0 V < V(NEN) < 5 V | -5 | | 5 | µA |
| **Undervoltage Monitoring** | | | | | | | |
| 501 | Voff | Undervoltage Threshold lo | | 3.0 | 3.5 | | V |
| 502 | Von | Undervoltage Threshold hi | | | 3.6 | 4.1 | V |
| 503 | Vhys | Undervoltage Hysteresis | | 35 | 100 | | mV |
| 504 | tp()shut | Undervoltage Lockout Delay | | | 20 | | µs |

## ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 4.5...35 V, Tj = -40...125 °C, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **Temperature Monitoring** | | | | | | | |
| 601 | Toff | Shutdown Temperature Threshold | NEN = lo | 130 | 150 | 170 | °C |
| 602 | ΔToff | Temperature Hysteresis | NEN = lo | | 8 | | °C |

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We understand suitable application of our published designs to be state-of-the-art technology which can no longer be classed as inventive under sthestipulations of patent law. Our explicit application notes are to be treated only as mere examples of the many possible and extremely advantageous uses our products can be put to.

## ELECTRICAL CHARACTERISTICS: Diagrams

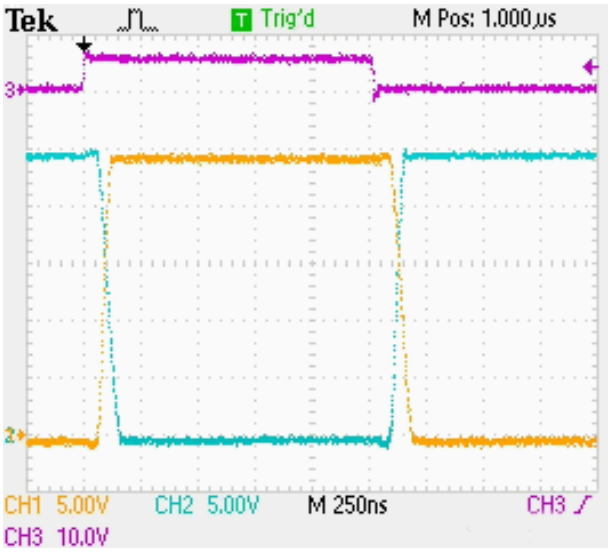


Figure 1: Example of moderate slew rate with un-loadad Ox and NOx outputs (VB = 24 V)

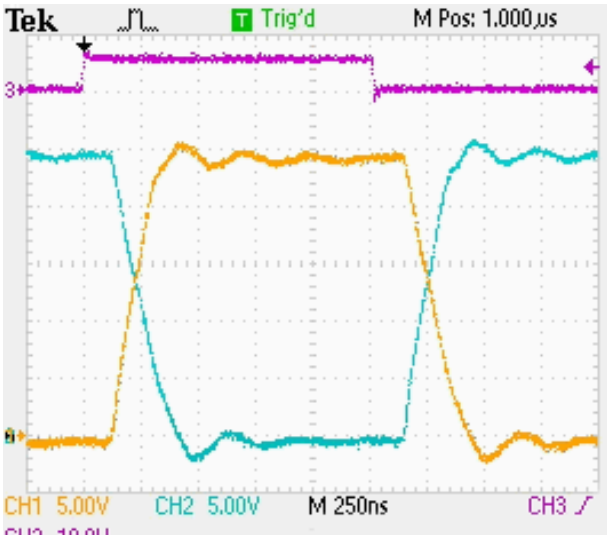


Figure 2: Example of typical line end signal with- out termination (VB = 24 V, length of cable 10 m)

**APPLICATION NOTE**

**Reverse polarity and circuit protection**

For reverse polarity protection electronic circuitry are usually powered via a diode D in the supply line. Under normal operating conditions, this diode will not affect function of the circuitry when the additional forward voltage drop across the diode is accounted for operating voltage specification.

If the supply voltage Vsupply is suddenly reversed, a load capacitor C may be still fully charged. Therefore, the diode D has to be selected to withstand a voltage difference of at least twice the maximum supply voltage. Since the reverse polarity protection diode D prevents discharging of the load capacitor C, especially at low power consumption injected charge through disturbances may in general result in capacitor voltage ex- ceeding maximum ratings, leading to malfunction or destruction of circuitry and associated parts. Thus EMC requirements will afford more external circuitry due to the introduction of a reverse polarity diode.

Figure 3 shows the GC-01 with the diode D for reverse polarity protection and additional protective devices TS and ZD.

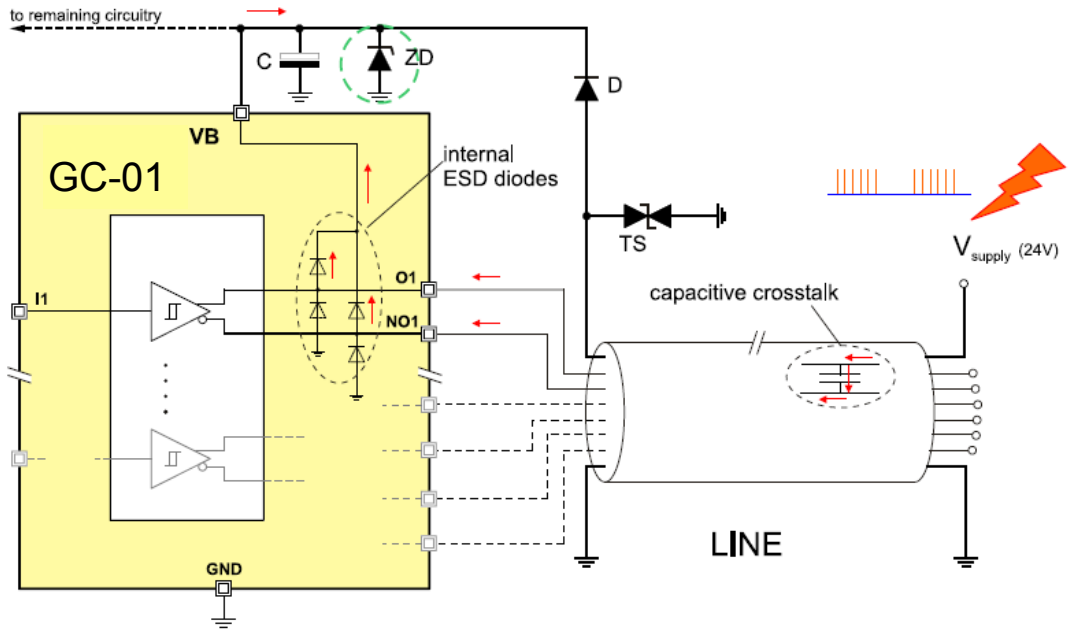


Figure 3: Circuit schematic showing protective devices

D: reverse polarity protective diode; TS: bidirectional suppressor diode; ZD: supply voltage limiting zener diode

For over-voltage protection, the suppressor diode TS absorbs transients on supply line injected externally on the cable. Clamp voltage of the diode TS should be rated slightly above maximum specified supply voltage.

Due to capacitive crosstalk between the wires in the cable of the supply line, additional currents may be injected into the circuitry during transients via the driver pins of GC-01 connected directly to the cable. These currents can be passed to ground or to VB by the internal ESD diodes of the GC-01. Whereas negative current injection will simply be drained off to ground, positive current injection will charge capacitor C further to higher voltages.

By introducing an additional Zener diode ZD in parallel to capacitor C, excessive charge can be drained off, thus limiting circuitry supply voltage to a safe value, as shown in fig. 4.

**Suggested protective devices**

As stated above, diode D must withstand at least twice the maximum operating voltage. Assuming VBmax specified to be 30V, reverse voltage $V_{R,D}$ of the diode D then should be at least 60 V. Current rating depends on total power consumption of the circuitry, but is usually below 1 amps. Therefore, typical 1 amps rated rectifier diodes like 1N4002 (with $V_{R,D}$ = 100 V) through 1N4007 (with $V_{R,D}$ = 1000 V) or equivalent types (BA157 through BA159) can be used. At VBmax of 30V, neither the suppressor diode TS nor the Zener diode ZD should draw substantial current. Therefore, their breakdown voltage should be chosen to be some volts higher. A 36 V rated suppressor diode with 1.5kW pulse power capability like a 1N6284 or 1.5KE36 the minimum breakdown voltage measured at a test current of 1 mA is stated as 32.4 V. Also, a zener diode like a BZT03C36 rated for 36 V also shows a minimum breakdown voltage of 32.4 V, but measured at test current of 10 mA.

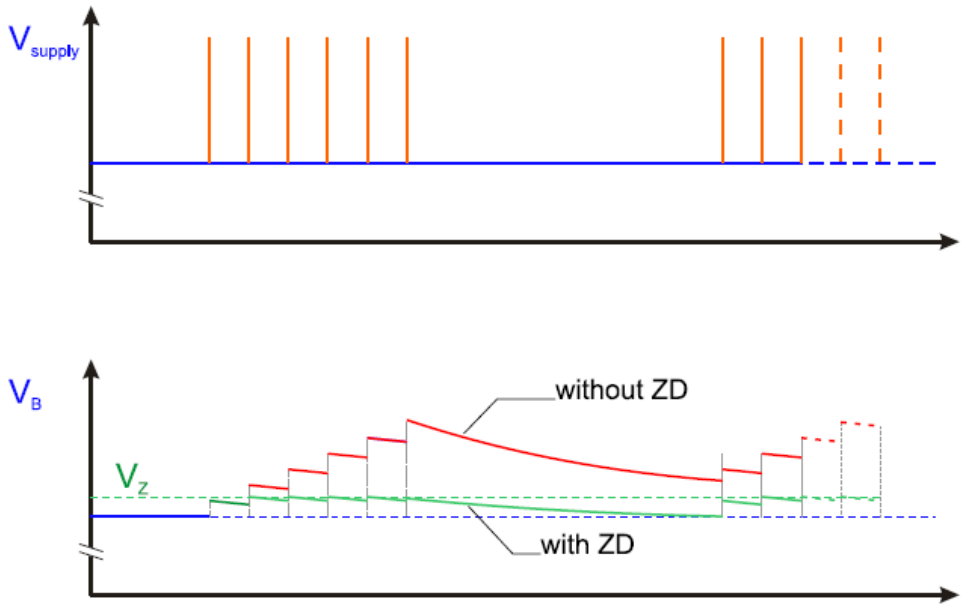


Figure 4: Using zener diode ZD to limit circuit supply voltage

**ORDERING INFORMATION**

| Type | Package | Order Designation |
|---|---|---|
| GC-01 | SO16N | GC-01 SO16N |

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