

iC-HE

TRIPLE DIFFERENTIAL LINE DRIVER



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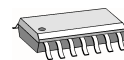
FEATURES

- ◆ Complementary short-circuit-proof push-pull driver stages for RS422 and 24 V applications up to 2 MHz
- ◆ SO14N package pin-compatible to ET9600
- ◆ 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 with excessive temperature
- ◆ 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)
- ◆ 50 mA LED driver with ISET input for current control

APPLICATIONS

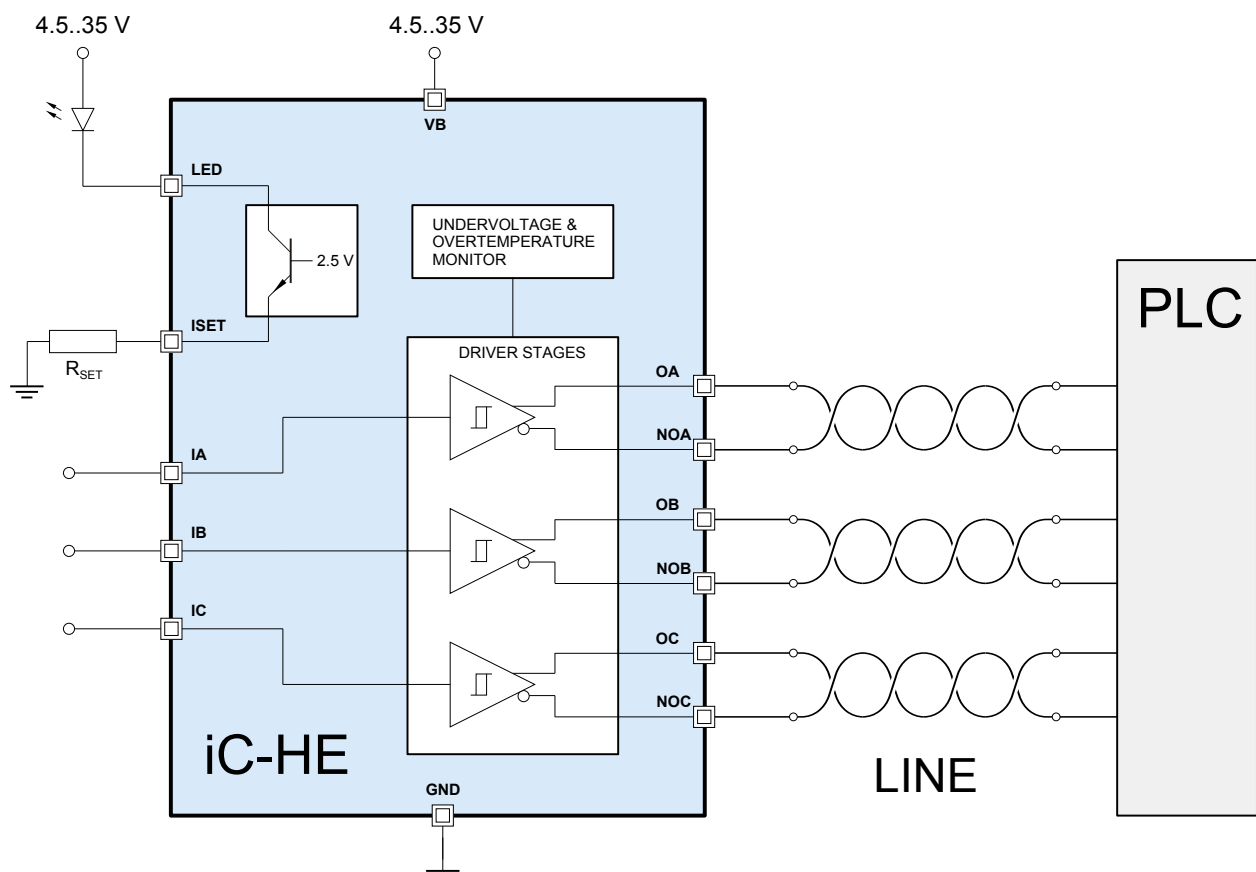
- ◆ Line drivers for 24 V control engineering
- ◆ Linear scales and encoders
- ◆ Sensor systems

PACKAGES



SO14N

BLOCK DIAGRAM



C2501080-1

iC-HE

TRIPLE DIFFERENTIAL LINE DRIVER



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DESCRIPTION

The iC-HE is a three channel line driver with complementary outputs optimized for line impedances in the range of 75 Ω .

The push-pull output stages can deliver at least 200 mA from 24 V supply and are short-circuit-proof and current-limited, shutting down with excessive temperature or undervoltage condition.

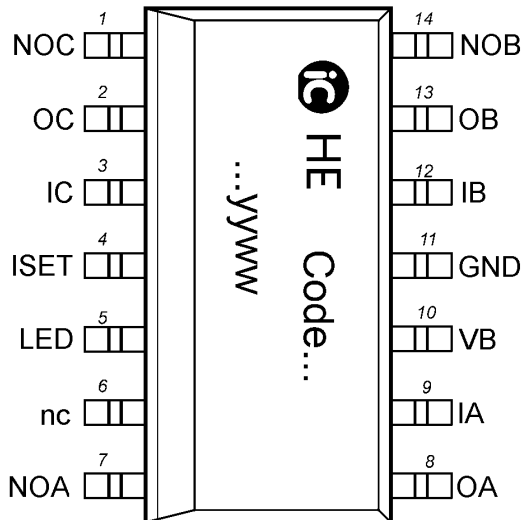
All inputs are compatible with CMOS and TTL levels.

The emitter and collector outputs of an on-chip NPN transistor is available for driving an external light emitting diode. The base of the transistor is connected to an internal reference voltage of 2.5 V. Collector current at pin LED can be controlled by the value of the resistor connected between ISET and ground.

The device is protected against ESD.

PACKAGING INFORMATION

PIN CONFIGURATION SO14N



PIN FUNCTIONS

No. Name Function

| | | |
|----|------|--------------------------|
| 1 | NOC | Inverted Output Driver C |
| 2 | OC | Output Driver C |
| 3 | IC | Input Driver C |
| 4 | ISET | LED Current Setting |
| 5 | LED | LED Current Output |
| 6 | n.c. | |
| 7 | NOA | Inverted Output Driver A |
| 8 | OA | Output Driver A |
| 9 | IA | Input Driver A |
| 10 | VB | Supply Voltage |
| 11 | GND | Ground |
| 12 | IB | Input Driver B |
| 13 | OB | Output Driver B |
| 14 | NOB | Inverted Output Driver B |

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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 | | | Unit |
|----------|---------|-------------------------------------|---------------------------------------|------|------|------|
| | | | | Min. | Max. | |
| G001 | VB | Supply Voltage | | 0 | 40 | V |
| G002 | Vin() | Voltage at Inputs IA, IB, IC | | 0 | VB | V |
| G003 | V() | Voltage at Outputs OA..OC, NOA..NOC | | 0 | VB | V |
| G004 | I() | Current in Outputs OA..OC, NOA..NOC | | -500 | 500 | mA |
| G005 | V(LED) | Voltage at LED | | 0 | 40 | V |
| G006 | I(LED) | Current in LED | | -300 | 300 | mA |
| G007 | V(ISET) | Voltage at ISET | | 0 | 6 | V |
| G008 | I(ISET) | Current in ISET | | -300 | 15 | mA |
| G009 | Vd() | ESD Susceptibility | HBM, 100 pF discharged through 1.5 kΩ | | 2 | kV |
| G010 | Tj | Junction Temperature | | -40 | 150 | °C |
| G011 | Ts | Storage Temperature | | -40 | 150 | °C |

THERMAL DATA

| Item No. | Symbol | Parameter | Conditions | | | | Unit |
|----------|--------|---|---------------------------------------|------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| T01 | Ta | Operating Ambient Temperature (extended range to -40°C on request) | | -25 | | 125 | °C |
| T02 | Rthja | Thermal Resistance SO14N | surface mounted, no special heat sink | | 160 | | K/W |

All voltages are referenced to ground unless otherwise stated.

All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

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ELECTRICAL CHARACTERISTICS

Operating Conditions: $V_B = 4.5 \dots 35 \text{ V}$, $T_j = -40 \dots 125 \text{ }^\circ\text{C}$, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | | | | Unit |
|---|-----------------------------|---|--|-------------|------|-------------|----------------------|
| | | | | Min. | Typ. | Max. | |
| Total Device | | | | | | | |
| 001 | V_B | Permissible Supply Voltage | | 4.5 | | 35 | V |
| 002 | $V(\text{LED})$ | Permissible Voltage at LED | no clamp diode to V_B | 4.5 | | 35 | V |
| 003 | $I(V_B)$ | Supply Current in VCC | no loads on outputs, ISET open | | 2.6 | 4 | mA |
| 004 | $V_c(\text{lo})$ | Clamp Voltage low at Ix inputs | $I() = -1 \text{ mA}$ | -1.2 | | -0.4 | V |
| 005 | $V_c(\text{hi})$ | Clamp Voltage high at Ix inputs | $I() = 1 \text{ mA}$ | $V_B + 0.4$ | | $V_B + 1.2$ | V |
| 006 | $V_c(\text{lo})$ | Clamp Voltage lo at OA, OB, OC, NOA, NOB, NOC | $V_B = 0 \text{ V}$, $I() = -10 \text{ mA}$ | -1.2 | | -0.4 | V |
| 007 | $V_c(\text{hi})$ | Clamp Voltage hi at OA, OB, OC, NOA, NOB, NOC | $V_B = 0 \text{ V}$, $I() = 10 \text{ mA}$ | $V_B + 0.4$ | | $V_B + 1.2$ | V |
| 008 | $V_c(\text{LED})\text{lo}$ | Clamp Voltage low at LED | $I() = -10 \text{ mA}$ | -1.2 | | -0.4 | V |
| 009 | $V_c(\text{LED})\text{hi}$ | Clamp Voltage high at LED | $I() = 10 \text{ mA}$ | 41 | | 58 | V |
| 010 | $V_c(\text{ISET})\text{lo}$ | Clamp Voltage low at ISET | $V_B = 0 \text{ V}$, $I() = -10 \text{ mA}$ | -1.2 | | -0.4 | V |
| 011 | $V_c(\text{ISET})\text{hi}$ | Clamp Voltage high at ISET | $V_B = 0 \text{ V}$ | 0.8 | | 2.4 | V |
| Driver Outputs Ox, NOx (x = A...C) | | | | | | | |
| 101 | $V_s(\text{lo})$ | Saturation voltage low | $I(A) = 40 \text{ mA}$ | | 0.2 | 0.5 | V |
| 102 | $V_s(\text{hi})$ | Saturation voltage high | $I(A) = -40 \text{ mA}$ | | 0.3 | 0.7 | V |
| 103 | $I_{\text{out}}(\text{hi})$ | Output current lo | $V_B = 30 \text{ V}$, $V(\text{Ox}, \text{NOx}) = 3 \text{ V}$ | 40 | 60 | 90 | mA |
| 104 | $I_{\text{out}}(\text{hi})$ | Output current hi | $V_B = 30 \text{ V}$, $V(\text{Ox}, \text{NOx}) = V_B - 3 \text{ V}$ | -90 | -60 | -40 | mA |
| 105 | $I_{\text{sc}}(\text{lo})$ | Short-Circuit Current lo | $V_B = 30 \text{ V}$, $V(\text{Ox}, \text{NOx}) = V_B$ | | 200 | 500 | mA |
| 106 | $I_{\text{sc}}(\text{hi})$ | Short-Circuit Current hi | $V(\text{Ox}, \text{NOx}) = 0 \text{ V}$ | -500 | -200 | | mA |
| 107 | $R_{\text{out}}()$ | Output Resistance | $V_B = 10 \dots 30 \text{ V}$, $V(\text{Ox}) = 0.5 * V_B$ | 50 | 75 | 110 | Ω |
| 108 | $SR(\text{lo}, \text{hi})$ | Slew-Rate lo, hi | $V_B = 24 \text{ V}$, $CL = 100 \text{ pF}$ | | 400 | | V/ μs |
| 109 | $tp(\text{lo}, \text{hi})$ | Delay Time lo,hi | not tested, guaranteed by design | | 75 | 200 | ns |
| 110 | $dtp()$ | Delay Time Difference | not tested, guaranteed by design | -35 | | 35 | ns |
| 111 | $I_{\text{lk}}()$ | Output Leakage Current | at overtemperature shutdown | -100 | | 100 | μA |
| Driver Inputs Ix (x=A...C) | | | | | | | |
| 201 | $V_t(\text{lo})$ | Threshold Voltage lo | | 0.8 | | | V |
| 202 | $V_t(\text{hi})$ | Threshold Voltage hi | | | | 2.4 | V |
| 203 | $V_t(\text{hys})$ | Input Hysteresis | | 0.1 | 0.2 | | V |
| 204 | $I()$ | Input Leakage Current in Ix | $0 \text{ V} < V(I_x) < 5 \text{ V}$ | -5 | | 5 | μA |
| Undervoltage Detection | | | | | | | |
| 501 | V_{off} | Undervoltage Threshold lo | | 2 | 3.4 | | V |
| 502 | V_{on} | Undervoltage Threshold hi | | | 3.5 | 4.1 | V |
| 503 | V_{hys} | Hysteresis | | 35 | 100 | | mV |
| 504 | $tp(\text{shut})$ | Reset Delay Time | | | 20 | | μs |
| Thermal Shutdown | | | | | | | |
| 601 | T_{off} | Shutdown Temperature | | 130 | 150 | 170 | $^\circ\text{C}$ |
| 602 | ΔT_{off} | Hysteresis | | | 8 | | $^\circ\text{C}$ |
| LED driver | | | | | | | |
| 701 | $TC(\text{ISET})$ | Temp.- Koeffizient at ISET | $I(\text{ISET}) = 10 \text{ mA}$ | | 2.0 | | mV/ $^\circ\text{K}$ |
| 702 | $V(\text{ISET})$ | Voltage at ISET | $T_j = 27 \text{ }^\circ\text{C}$; $I(\text{ISET}) = 1 \text{ mA}$ | 1.7 | 1.93 | 2.2 | V |
| 703 | $V(\text{ISET})$ | Voltage at LED | $T_j = 27 \text{ }^\circ\text{C}$; $I(\text{ISET}) = 10 \text{ mA}$ | 1.5 | 1.82 | 2.1 | V |
| 704 | $V(\text{ISET})$ | Voltage at ISET | $T_j = 27 \text{ }^\circ\text{C}$; $I(\text{ISET}) = 50 \text{ mA}$ | 1.3 | 1.64 | 2 | V |
| 705 | CR | Current Ratio $I(\text{LED})/I(\text{ISET})$ | $I(\text{ISET}) = 1 \dots 50 \text{ mA}$ | 0.97 | | 1 | |
| 706 | $I_{\text{sc}}(\text{LED})$ | Short-Circuit Current in LED | $V(\text{ISET}) = 0 \text{ V}$ | 65 | 125 | 250 | mA |
| 707 | $V_s(\text{LED})$ | Saturation Voltage NPN | $V_s(\text{LED}) = V(\text{LED}) - V(\text{ISET})$; $I(\text{LED}) = 1 \text{ mA}$ | | 0.15 | 0.4 | V |
| 708 | $V_s(\text{LED})$ | Saturation Voltage NPN | $V_s(\text{LED}) = V(\text{LED}) - V(\text{ISET})$; $I(\text{LED}) = 50 \text{ mA}$ | | 0.55 | 1.2 | V |
| 709 | $I_{\text{lk}}(\text{LED})$ | Leakage Current in LED | ISET open, $V(\text{LED}) = 35 \text{ V}$ | | | 100 | μA |

ELECTRICAL CHARACTERISTICS

Operating Conditions: $V_B = 4.5...35\text{ V}$, $T_j = -40...125\text{ }^\circ\text{C}$, unless otherwise noted

| Item No. | Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------|----------------------|------------------------|---|------|------|------|---------------|
| | | | | | | | |
| 710 | $I_{lk}(\text{LED})$ | Leakage Current in LED | over temperature condition, $V(\text{LED}) = 35\text{ V}$ | | | 200 | μA |

ELECTRICAL CHARACTERISTICS: Diagrams

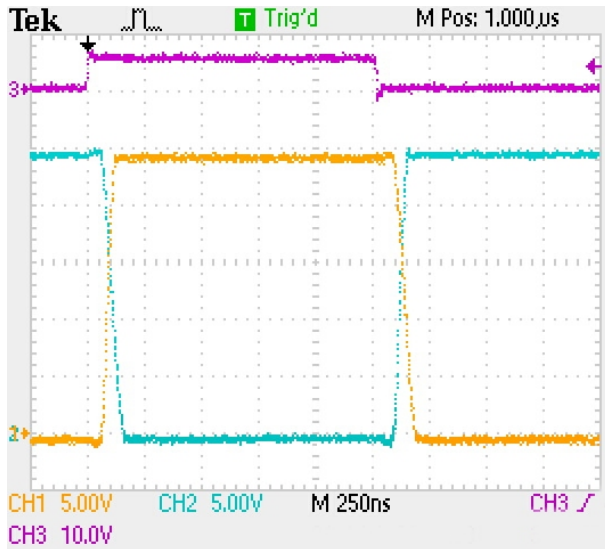


Figure 1: Example of moderate slew rate with un-loadad Ox and NOx outputs ($V_B = 24\text{ V}$)

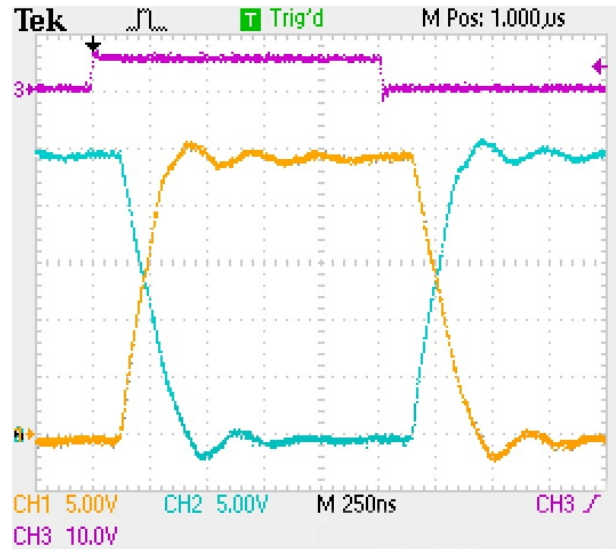


Figure 2: Example of typical line end signal without termination ($V_B = 24\text{ V}$, length of cable 10 m)

DESIGN REVIEW: Notes on Chip Functions

| iC-HE X | | |
|---------|--------------------------|---------------------------------------|
| No. | Function, Parameter/Code | Description and Application Hints |
| | | No further notes at time of printing. |

Table 4: Notes on chip functions regarding iC-HE chip revision X

REVISION HISTORY

| Rel. | Rel. Date* | Chapter | Modification | Page |
|------|------------|---------|---------------|-----------|
| A1 | 2009-11-30 | ALL | First Release | all pages |

| Rel. | Rel. Date* | Chapter | Modification | Page |
|------|------------|--|---|-----------|
| A2 | 2020-07-29 | All | Label "preliminary" removed | all pages |
| | | BLOCK DIAGRAM | Color of block diagram changed to blue | 2 |
| | | DESIGN REVIEW: Notes on Chip Functions | Section DESIGN REVIEW introduced for completeness | 6 |
| | | Revision History | introduced and updated | 6 |
| | | Disclaimer | current version at time of printing | 6 |
| | | ORDERING INFORMATION | order handling team contact information added | last page |

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* Release Date format: YYYY-MM-DD

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ORDERING INFORMATION

| Type | Package | Order Designation |
|-------|---------|-------------------|
| iC-HE | SO14N | iC-HE SO14N |

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