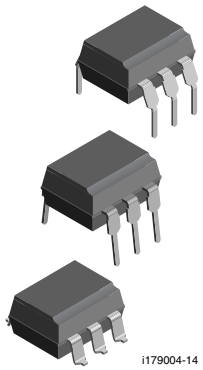
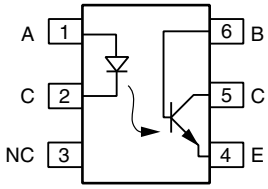
# Optocoupler, Phototransistor Output, with Base Connection



i179004-14




## FEATURES

- Isolation test voltage 5000 $V_{RMS}$
- Interfaces with common logic families
- Input-output coupling capacitance < 0.5 pF
- Industry standard dual-in-line 6 pin package
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb-free

e3

RoHS COMPLIANT

## APPLICATIONS

- AC mains detection
- Reed relay driving
- Switch mode power supply feedback
- Telephone ring detection
- Logic ground isolation
- Logic coupling with high frequency noise rejection

## AGENCY APPROVALS

- UL file no. E52744 (pending)
- cUL tested to CSA 22.2 bulletin 5A
- DIN EN 60747-5-2 (VDE 0884)/DIN EN 60747-5-5 (pending), available with option 1
- BSI: EN 60065, EN 60950-1
- FIMKO
- CQC

## DESCRIPTION

This datasheet presents five families of Vishay industry standard single channel phototransistor couplers. These families include the 4N35, 4N36, 4N37, 4N38 couplers.

Each optocoupler consists of gallium arsenide infrared LED and a silicon NPN phototransistor.

These couplers are Underwriters Laboratories (UL) listed to comply with a 5000 $V_{RMS}$ isolation test voltage.

This isolation performance is accomplished through Vishay double molding isolation manufacturing process. Comliance to DIN EN 60747-5-5 partial discharge isolation specification is available for these families by ordering option 1.

These isolation processes and the Vishay ISO9001 quality program results in the highest isolation performance available for a commecial plastic phototransistor optocoupler.

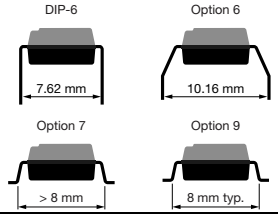
The devices are available in lead formed configuration suitable for surface mounting and are available either on tape and reel, or in standard tube shipping containers.

**Note**

- For additional design information see application note 45 normalized curves

## ORDERING INFORMATION

| 4 | N | 3 | x | - | X | 0 | # | # | T |
|---|---|---|---|---|---|---|---|---|---|
| PART NUMBER | | | | | PACKAGE OPTION | | | | TAPE AND REEL |




| AGENCY CERTIFIED/PACKAGE | CTR (%) | | | |
|---|---|---|---|---|
| | 10 mA | | | 20 mA |
| **UL, cUL, BSI, FIMKO** | **≥ 100** | | | **≥ 20** |
| DIP-6 | 4N35-X000 | 4N36-X000 | 4N37-X000 | 4N38 |
| DIP-6, 400 mil, option 6 | 4N35-X006 | - | 4N37-X006 | - |
| SMD-6, option 7 | 4N35-X007T (1) | 4N36-X007 | 4N37-X007 | 4N38-X007T (1) |
| SMD-6, option 9 | 4N35-X009T (1) | 4N36-X009T (1) | 4N37-X009 | 4N38-X009T |
| **VDE, UL, cUL, BSI, FIMKO** | **≥ 100** | | | **≥ 20** |
| DIP-6 | 4N35-X001 | - | 4N37-X001 | - |
| DIP-6, 400 mil, option 6 | 4N35-X016 | - | - | - |
| SMD-6, option 7 | 4N35-X017T (1) | - | - | - |
| SMD-6, option 9 | 4N35-X019T | - | - | - |

**Notes**

- Additional options may be possible, please contact sales office.

(1) Also available in tubes; do not put T on end.



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| **ABSOLUTE MAXIMUM RATINGS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | |
|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **VALUE** | **UNIT** |
| **INPUT** | | | | |
| Reverse voltage | | $V_R$ | 6 | V |
| Forward current | | $I_F$ | 60 | mA |
| Surge current | t ≤ 10 µs | $I_{FSM}$ | 2.5 | A |
| Power dissipation | | $P_{diss}$ | 70 | mW |
| **OUTPUT** | | | | |
| Collector emitter breakdown voltage | | $V_{CEO}$ | 70 | V |
| Emitter base breakdown voltage | | $V_{EBO}$ | 7 | V |
| Collector current | | $I_C$ | 50 | mA |
| Collector peak current | $t_p/T$ = 0.5, $t_p$ ≤ 10 ms | $I_{CM}$ | 100 | mA |
| Output power dissipation | | $P_{diss}$ | 150 | mW |
| **COUPLER** | | | | |
| Isolation test voltage | t = 1 s | $V_{ISO}$ | 5000 | $V_{RMS}$ |
| Creepage distance | | | ≥ 7 | mm |
| Clearance distance | | | ≥ 7 | mm |
| Isolation thickness between emitter and detector | | | ≥ 0.4 | mm |
| Comparative tracking index | DIN IEC 112/VDE 0303, part 1 | | ≥ 175 | |
| Isolation resistance | $V_{IO}$ = 500 V, $T_{amb}$ = 25 °C | $R_{IO}$ | ≥ $10^{12}$ | Ω |
| | $V_{IO}$ = 500 V, $T_{amb}$ = 100 °C | $R_{IO}$ | ≥ $10^{11}$ | Ω |
| Storage temperature | | $T_{stg}$ | - 55 to + 150 | °C |
| Operating temperature | | $T_{amb}$ | - 55 to + 100 | °C |
| Soldering temperature (1) | 2 mm from case, ≤ 10 s | $T_{sld}$ | 260 | °C |

**Notes**

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.

(1) Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering condditions for through hole devices (DIP).

| **ELECTRICAL CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **PART** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **INPUT** | | | | | | | |
| Forward voltage (1) | $I_F$ = 10 mA | | $V_F$ | | 1.2 | 1.5 | V |
| | $I_F$ = 10 mA, $T_{amb}$ = - 55 °C | | $V_F$ | 0.9 | 1.3 | 1.7 | V |
| Reverse current (1) | $V_R$ = 6 V | | $I_R$ | | 0.1 | 10 | µA |
| Capacitance | $V_R$ = 0 V, f = 1 MHz | | $C_O$ | | 25 | | pF |
| **OUTPUT** | | | | | | | |
| Collector emitter breakdown voltage (1) | $I_C$ = 1 mA | 4N35 | $BV_{CEO}$ | 30 | | | V |
| | | 4N36 | $BV_{CEO}$ | 30 | | | V |
| | | 4N37 | $BV_{CEO}$ | 30 | | | V |
| | | 4N38 | $BV_{CEO}$ | 80 | | | V |
| Emitter collector breakdown voltage (1) | $I_E$ = 100 µA | | $BV_{ECO}$ | 7 | | | V |
| Collector base breakdown voltage (1) | $I_C$ = 100 µA, $I_B$ = 1 µA | 4N35 | $BV_{CBO}$ | 70 | | | V |
| | | 4N36 | $BV_{CBO}$ | 70 | | | V |
| | | 4N37 | $BV_{CBO}$ | 70 | | | V |
| | | 4N38 | $BV_{CBO}$ | 80 | | | V |


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| **ELECTRICAL CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **PART** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **OUTPUT** | | | | | | | |
| Collector emitter leakage current (1) | $V_{CE}$ = 10 V, $I_F$ = 0 | 4N35 | $I_{CEO}$ | | 5 | 50 | nA |
| | | 4N36 | $I_{CEO}$ | | 5 | 50 | nA |
| | $V_{CE}$ = 10 V, $I_F$ = 0 | 4N37 | $I_{CEO}$ | | 5 | 50 | nA |
| | $V_{CE}$ = 60 V, $I_F$ = 0 | 4N38 | $I_{CEO}$ | | | 50 | nA |
| | $V_{CE}$ = 30 V, $I_F$ = 0, $T_{amb}$ = 100 °C | 4N35 | $I_{CEO}$ | | | 500 | µA |
| | | 4N36 | $I_{CEO}$ | | | 500 | µA |
| | | 4N37 | $I_{CEO}$ | | | 500 | µA |
| | $V_{CE}$ = 60 V, $I_F$ = 0, $T_{amb}$ = 100 °C | 4N38 | $I_{CEO}$ | | 6 | | µA |
| Collector emitter capacitance | $V_{CE}$ = 0 | | $C_{CE}$ | | 6 | | pF |
| coupler | | | | | | | |
| Resistance, input output (1) | $V_{IO}$ = 500 V | | $R_{IO}$ | $10^{11}$ | | | Ω |
| Capacitance, input output | f = 1 MHz | | $C_{IO}$ | | 0.5 | | pF |

**Notes**

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.

(1) Indicates JEDEC registered value.

| **CURRENT TRANSFER RATIO** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **PART** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| $I_C/I_F$ (1) | $V_{CE}$ = 10 V, $I_F$ = 10 mA | 4N35 | $CTR_{DC}$ | 100 | | | % |
| | | 4N36 | $CTR_{DC}$ | 100 | | | % |
| | | 4N37 | $CTR_{DC}$ | 100 | | | % |
| | $V_{CE}$ = 10 V, $I_F$ = 20 mA | 4N38 | $CTR_{DC}$ | 20 | | | % |
| | $V_{CE}$ = 10 V, $I_F$ = 10 mA, $T_A$ = - 55 °C to + 100 °C | 4N35 | $CTR_{DC}$ | 40 | 50 | | % |
| | | 4N36 | $CTR_{DC}$ | 40 | 50 | | % |
| | | 4N37 | $CTR_{DC}$ | 40 | 50 | | % |
| | | 4N38 | $CTR_{DC}$ | | 30 | | % |

**Note**

(1) Indicates JEDEC registered values.

| **SWITCHING CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| Turn-on time (1) | $V_{CC}$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω | $t_{on}$ | | 10 | | µs |
| Turn-off time (1) | $V_{CC}$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω | $t_{off}$ | | 10 | | µs |

**Note**

(1) Indicates JEDEC registered values.

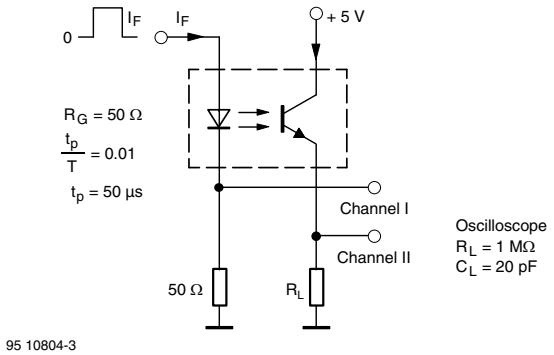



Fig. 1 - Test Circuit, Non-Saturated Operation

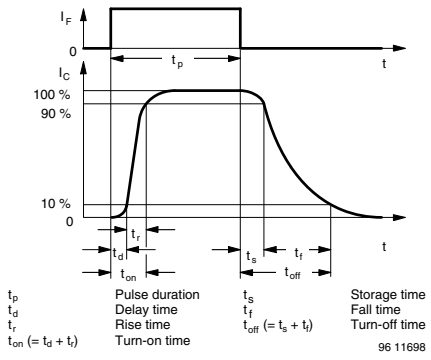



Fig. 2 - Switching Times



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**TYPICAL CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified)

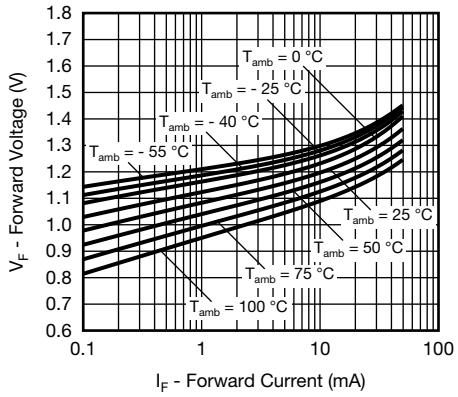



Fig. 3 - Forward Voltage vs. Forward Current

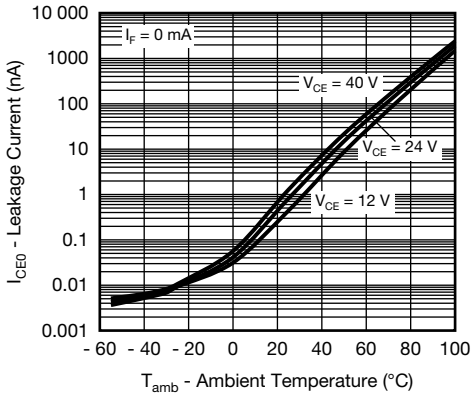



Fig. 6 - Leakage Current vs. Ambient Temperature

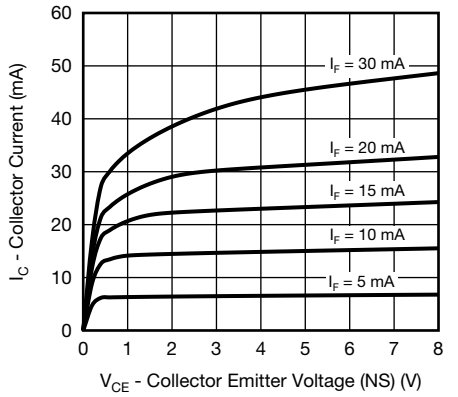



Fig. 4 - Collector Current vs. Collector Emitter Voltage (NS)

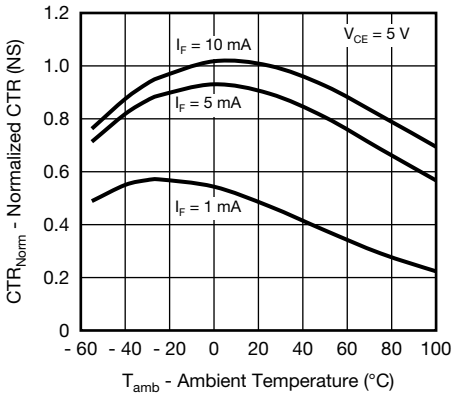



Fig. 7 - Normalized CTR (NS) vs. Ambient Temperature

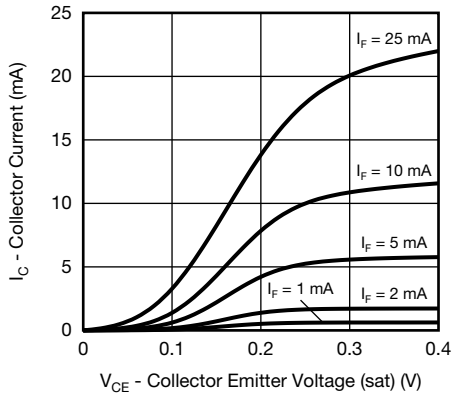



Fig. 5 - Collector Current vs. Collector Emitter Voltage (sat)

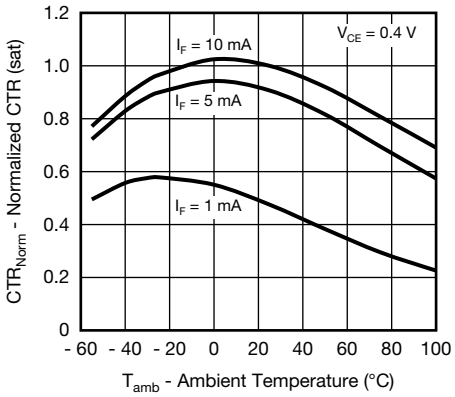



Fig. 8 - Normalized CTR (sat) vs. Ambient Temperature


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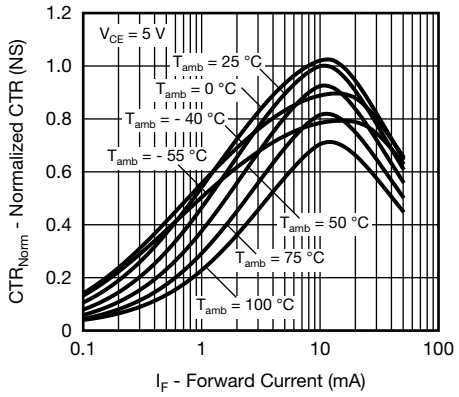



Fig. 9 - Normalized CTR (NS) vs. Forward Current

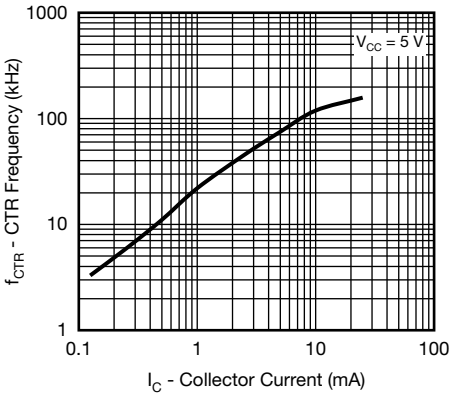



Fig. 12 - CTR Frequency vs. Collector Current

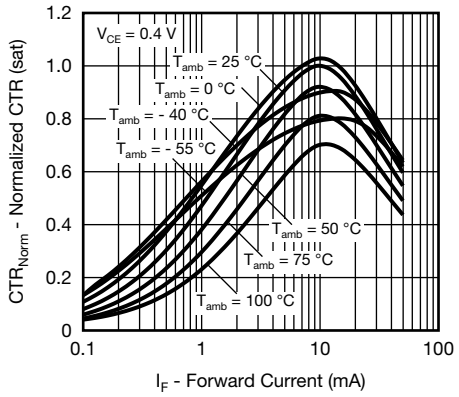



Fig. 10 - Normalized CTR (sat) vs. Forward Current

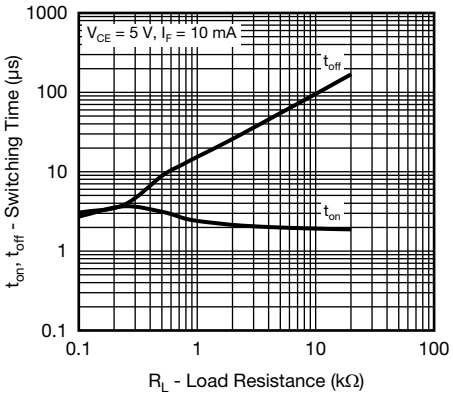



Fig. 13 - Switching Time vs. Load Resistance

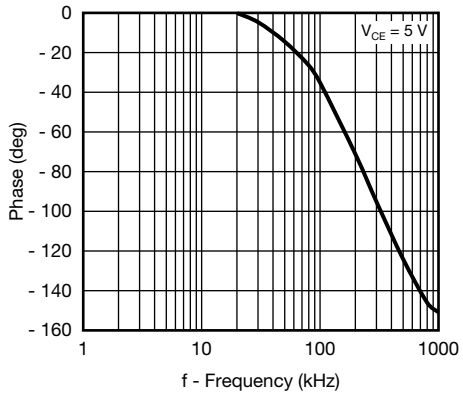
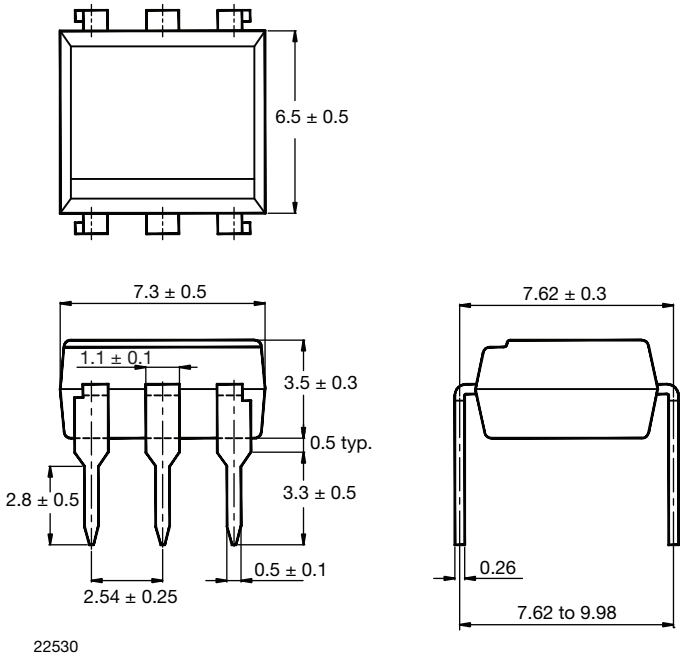


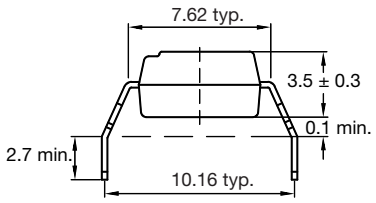

Fig. 11 - CTR Frequency vs. Phase Angle


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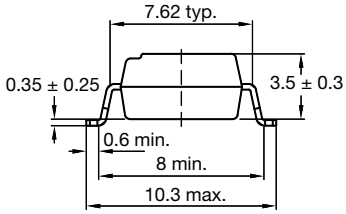
## PACKAGE DIMENSIONS in millimeters



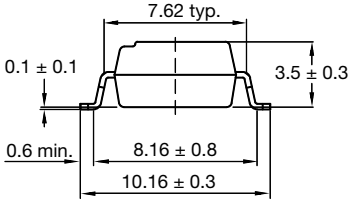

**Option 6**

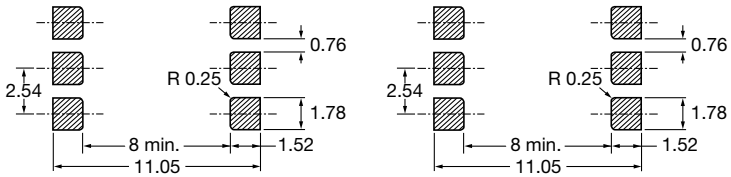



**Option 7**



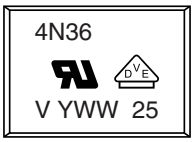

**Option 9**




20802-34

## PACKAGE MARKING




**Notes**

- VDE logo is only marked on option 1 parts. Option information is not marked on the part.
- Tape and reel suffix (T) is not part of the package marking.



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