## Optocoupler, Phototransistor Output



## DESCRIPTION

The 4N25V, 4N25GV, 4N35V, 4N35GV series consists of a phototransistor optically coupled to a gallium arsenide infrared-emitting diode in a 6-lead plastic dual inline package.

## VDE STANDARDS

These couplers perform safety functions according to the following equipment standards:

## DIN EN 60747-5-5 (VDE 0884)

Optocoupler for electrical safety requirements

## IEC 60950

Office machines (applied for reinforced isolation for mains voltage $\leq 400 \mathrm{~V}_{\mathrm{RMS}}$ )
VDE 0804
Telecommunication apparatus and data processing
IEC 60065
Safety for mains-operated electronic and related household apparatus

## FEATURES

- Special construction: therefore, extra low coupling capacity of typical 0.2 pF , high common mode rejection
- Low temperature coefficient of CTR
- Rated isolation voltage (RMS includes DC) $\mathrm{V}_{\text {IOWM }}=600 \mathrm{~V}_{\text {RMS }}$ ( 848 V peak)

- Rated recurring peak voltage (repetitive) $\mathrm{V}_{\text {IORM }}=600 \mathrm{~V}_{\text {RMS }}$
- Thickness through insulation $\geq 0.4 \mathrm{~mm}$
- Creepage current resistance according to VDE 0303/ IEC 60112 comparative tracking index: CTI $\geq 275$
- Rated impulse voltage (transient overvoltage) $\mathrm{V}_{\text {IOтм }}=6 \mathrm{kV}$ peak
- Isolation test voltage (partial discharge test voltage) $\mathrm{V}_{\mathrm{pd}}=1.6 \mathrm{kV}$
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC


## APPLICATIONS

- Switch-mode power supplies
- Line receiver
- Computer peripheral interface
- Microprocessor system interface
- Circuits for safe protective separation against electrical shock according to safety class II (reinforced isolation):
- for appl. class I - IV at mains voltage $\leq 300 \mathrm{~V}$ - for appl. class I - III at mains voltage $\leq 600 \mathrm{~V}$ according to DIN EN 60747-5-5


## AGENCY APPROVALS

- UL1577, file no. E52744, double protection
- BSI: BS EN 41003, BS EN 60065 (BS 415), pending
- DIN EN 60747-5-5 (VDE 0884)
- FIMKO (SETI): EN 60950, certificate no. FI25155

| ORDER INFORMATION (1) |  |
| :--- | :---: |
| PART | REMARKS |
| 4N25GV | CTR $>20 \%$ wide lead spacing, DIP-6 |
| $4 N 35 G V$ | CTR $>100 \%$ wide lead spacing, DIP-6 |
| $4 N 25 \mathrm{~V}$ | CTR $>20 \%$, DIP-6 |
| $4 N 35 \mathrm{~V}$ | CTR $>100 \%$, DIP-6 |

## Note

${ }^{(1)} G=$ leadform $10.16 \mathrm{~mm} ; G$ is not marked on the body.

## Vishay Semiconductors Optocoupler, Phototransistor Output

| ABSOLUTE MAXIMUM RATINGS (1) |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITION | SYMBOL | VALUE | UNIT |
| INPUT |  |  |  |  |
| Reverse voltage |  | $\mathrm{V}_{\mathrm{R}}$ | 5 | V |
| Forward current |  | $\mathrm{I}_{\mathrm{F}}$ | 60 | mA |
| Forward surge current | $\mathrm{t}_{\mathrm{p}} \leq 10 \mu \mathrm{~s}$ | $\mathrm{I}_{\text {FSM }}$ | 3 | A |
| Power dissipation |  | $\mathrm{P}_{\text {diss }}$ | 70 | mW |
| Junction temperature |  | $\mathrm{T}_{\mathrm{j}}$ | 125 | ${ }^{\circ} \mathrm{C}$ |
| OUTPUT |  |  |  |  |
| Collector emitter voltage |  | $\mathrm{V}_{\text {CEO }}$ | 32 | V |
| Emitter collector voltage |  | $\mathrm{V}_{\text {ECO }}$ | 7 | V |
| Collector current |  | $\mathrm{I}_{\mathrm{C}}$ | 50 | mA |
| Collector peak current | $\mathrm{t}_{\mathrm{p}} / \mathrm{T}=0.5, \mathrm{t}_{\mathrm{p}} \leq 10 \mathrm{~ms}$ | $\mathrm{I}_{\text {CM }}$ | 100 | mA |
| Power dissipation |  | $\mathrm{P}_{\text {diss }}$ | 70 | mW |
| Junction temperature |  | $\mathrm{T}_{\mathrm{j}}$ | 125 | ${ }^{\circ} \mathrm{C}$ |
| COUPLER |  |  |  |  |
| Isolation test voltage (RMS) |  | $\mathrm{V}_{\text {ISO }}$ | 5000 | $\mathrm{V}_{\text {RMS }}$ |
| Total power dissipation |  | $\mathrm{P}_{\text {tot }}$ | 200 | mW |
| Ambient temperature range |  | $\mathrm{T}_{\text {amb }}$ | -55 to + 100 | ${ }^{\circ} \mathrm{C}$ |
| Storage temperature range |  | $\mathrm{T}_{\text {stg }}$ | -55 to + 125 | ${ }^{\circ} \mathrm{C}$ |
| Soldering temperature ${ }^{(2)}$ | 2 mm from case, $\mathrm{t} \leq 10 \mathrm{~s}$ | $\mathrm{T}_{\text {sld }}$ | 260 | ${ }^{\circ} \mathrm{C}$ |

## Notes

(1) $\mathrm{T}_{\text {amb }}=25^{\circ} \mathrm{C}$, unless otherwise specified.

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.
${ }^{(2)}$ Refer to wave profile for soldering conditions for through hole devices.

| ELECTRICAL CHARACTERISTICS (1) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| INPUT |  |  |  |  |  |  |
| Forward voltage | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}$ | $\mathrm{V}_{\mathrm{F}}$ |  | 1.2 | 1.4 | V |
| Junction capacitance | $\mathrm{V}_{\mathrm{R}}=0 \mathrm{~V}, \mathrm{f}=1 \mathrm{MHz}$ | $\mathrm{C}_{\mathrm{j}}$ |  | 50 |  | pF |
| OUTPUT |  |  |  |  |  |  |
| Collector emitter voltage | $\mathrm{I}_{\mathrm{C}}=1 \mathrm{~mA}$ | $\mathrm{V}_{\text {CEO }}$ | 32 |  |  | V |
| Emitter collector voltage | $\mathrm{I}_{\mathrm{E}}=100 \mu \mathrm{~A}$ | $\mathrm{V}_{\text {ECO }}$ | 7 |  |  | V |
| Collector emitter leakage current | $\begin{gathered} \mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=0, \\ \mathrm{~T}_{\mathrm{amb}}=100^{\circ} \mathrm{C} \\ \hline \end{gathered}$ | Iceo |  |  | 50 | nA |
|  | $\begin{gathered} \mathrm{V}_{\mathrm{CEE}}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=0, \\ \mathrm{~T}_{\mathrm{amb}}=100^{\circ} \mathrm{C} \end{gathered}$ | $I_{\text {ceo }}$ |  |  | 500 | nA |
| COUPLER |  |  |  |  |  |  |
| Collector emitter saturation voltage | $\mathrm{I}_{\mathrm{F}}=50 \mathrm{~mA}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}$ | $\mathrm{V}_{\text {CEsat }}$ |  |  | 0.3 | V |
| Cut-off frequency | $\begin{gathered} \hline \mathrm{V}_{\mathrm{CE}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}, \\ \mathrm{R}_{\mathrm{L}}=100 \Omega \end{gathered}$ | $\mathrm{f}_{\mathrm{c}}$ |  | 110 |  | kHz |
| Coupling capacitance | $\mathrm{f}=1 \mathrm{MHz}$ | $\mathrm{C}_{\mathrm{k}}$ |  | 1 |  | pF |

## Note

(1) $\mathrm{T}_{\mathrm{amb}}=25^{\circ} \mathrm{C}$, unless otherwise specified.

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.

| CURRENT TRANSFER RATIO |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITION | PART | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| $\mathrm{I}_{\mathrm{C}} / \mathrm{I}_{\mathrm{F}}$ | $\mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}$ | 4N25V | CTR | 20 | 100 |  | \% |
|  |  | 4N25GV | CTR |  |  |  |  |
|  |  | 4N35V | CTR | 100 | 150 |  | \% |
|  |  | 4N35GV | CTR |  |  |  |  |
|  | $\begin{gathered} \mathrm{V}_{\mathrm{CE}}=10 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}, \\ \mathrm{~T}_{\mathrm{amb}}=100^{\circ} \mathrm{C} \end{gathered}$ | 4N35V | CTR | 40 |  |  | \% |
|  |  | 4N35GV | CTR |  |  |  |  |


| MAXIMUM SAFETY RATINGS (1) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| INPUT |  |  |  |  |  |  |
| Forward current |  | $\mathrm{I}_{\mathrm{F}}$ |  |  | 130 | mA |
| OUTPUT |  |  |  |  |  |  |
| Power dissipation |  | $\mathrm{P}_{\text {diss }}$ |  |  | 265 | mW |
| COUPLER |  |  |  |  |  |  |
| Rated impulse voltage |  | $\mathrm{V}_{\text {IOTM }}$ |  |  | 6 | kV |
| Safety temperature |  | $\mathrm{T}_{\mathrm{si}}$ |  |  | 150 | ${ }^{\circ} \mathrm{C}$ |

## Note

${ }^{(1)}$ According to DIN EN 60747-5-5 (see figure 2). This optocoupler is suitable for safe electrical isolation only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.

INSULATION RATED PARAMETERS

| PARAMETER | TEST CONDITION | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Partial discharge test voltage routine test | $100 \%, \mathrm{t}_{\text {test }}=1 \mathrm{~s}$ | $V_{\text {pd }}$ | 1600 |  |  | V |
| Partial discharge test voltage lot test (sample test) | $\begin{gathered} \mathrm{t}_{\mathrm{Tr} \mathrm{r}}=60 \mathrm{~s}, \mathrm{t}_{\text {test }}=10 \mathrm{~s}, \\ \quad(\text { see figure 2) } \end{gathered}$ | $\mathrm{V}_{\text {IOTM }}$ | 6000 |  |  | V |
|  |  | $\mathrm{V}_{\mathrm{pd}}$ | 1400 |  |  | V |
| Insulation resistance | $\mathrm{V}_{10}=500 \mathrm{~V}$ | $\mathrm{R}_{\mathrm{l}}$ | $10^{12}$ |  |  | $\Omega$ |
|  | $\mathrm{V}_{10}=500 \mathrm{~V}, \mathrm{~T}_{\text {amb }}=100^{\circ} \mathrm{C}$ | $\mathrm{R}_{\mathrm{I}}$ | $10^{11}$ |  |  | $\Omega$ |
|  | $\begin{gathered} \mathrm{V}_{10}=500 \mathrm{~V}, \mathrm{~T}_{\mathrm{amb}}=150^{\circ} \mathrm{C} \\ \text { (construction test only) } \end{gathered}$ | $\mathrm{R}_{10}$ | $10^{9}$ |  |  | $\Omega$ |



Fig. 1 - Derating Diagram


Fig. 2 - Test Pulse Diagram for Sample Test according to DIN EN 60747-; IEC 60747

## Vishay Semiconductors Optocoupler, Phototransistor Output

| SWITCHING CHARACTERISTICS |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PARAMETER | TEST CONDITION | PART | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| Delay time (see figure 3) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\mathrm{d}}$ |  | 4 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $t_{d}$ |  | 2.5 |  | $\mu \mathrm{s}$ |
| Rise time (see figure 3) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\mathrm{r}}$ |  | 7 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \hline \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $t_{r}$ |  | 3 |  | $\mu \mathrm{s}$ |
| Fall time (see figure 3) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\mathrm{f}}$ |  | 6.7 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \hline \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $t_{f}$ |  | 4.2 |  | $\mu \mathrm{s}$ |
| Storage time (see figure 3) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\text {s }}$ |  | 0.3 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $t_{\text {s }}$ |  | 0.3 |  | $\mu \mathrm{s}$ |
| Turn-on time (see figure 3 ) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\text {on }}$ |  | 11 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $\mathrm{t}_{\text {on }}$ |  |  | 10 | $\mu \mathrm{s}$ |
| Turn-off time (see figure 3) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=5 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \\ \hline \end{gathered}$ | $\mathrm{t}_{\text {off }}$ |  | 7 |  | $\mu \mathrm{s}$ |
|  | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=2 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=100 \Omega$, | $\begin{gathered} \hline \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $\mathrm{t}_{\text {off }}$ |  |  | 10 | $\mu \mathrm{s}$ |
| Turn-on time (see figure 4) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=1 \mathrm{k} \Omega$, | $\begin{gathered} \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\text {on }}$ |  | 25 |  | $\mu \mathrm{s}$ |
|  |  | $\begin{gathered} \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $\mathrm{t}_{\text {on }}$ |  | 9 |  | $\mu \mathrm{s}$ |
| Turn-off time (see figure 4) | $\mathrm{V}_{\mathrm{S}}=5 \mathrm{~V}, \mathrm{I}_{\mathrm{F}}=10 \mathrm{~mA}, \mathrm{R}_{\mathrm{L}}=1 \mathrm{k} \Omega$, | $\begin{gathered} \hline \text { 4N25V } \\ \text { 4N25GV } \end{gathered}$ | $\mathrm{t}_{\text {off }}$ |  | 42.5 |  | $\mu \mathrm{s}$ |
|  |  | $\begin{gathered} \hline \text { 4N35V } \\ \text { 4N35GV } \end{gathered}$ | $\mathrm{t}_{\text {off }}$ |  | 25 |  | $\mu \mathrm{s}$ |



Fig. 3 - Test circuit, Non-Saturated Operation


9510844

Fig. 4 - Test Circuit, Saturated Operation


Fig. 5 - Switching Times

## TYPICAL CHARACTERISTICS

$\mathrm{T}_{\mathrm{amb}}=25^{\circ} \mathrm{C}$, unless otherwise specified


Fig. 6 - Total Power Dissipation vs. Ambient Temperature


Fig. 7 - Forward Current vs. Forward Voltage


Fig. 8 - Relative Current Transfer Ratio vs Ambient Temperature


Fig. 9 - Collector Dark Current vs. Ambient Temperature


Fig. 13 - Collector Emitter Saturation Voltage vs. Collector Current


Fig. 14 - DC Current Gain vs. Collector Current


Fig. 15 - Current Transfer Ratio vs. Forward Current


Fig. 12 - Collector Current vs. Collector Emitter Voltage


Fig. 11 - Collector Current vs. Forward Current


Fig. 10 - Collector Base Current vs. Forward Current

Optocoupler, Phototransistor Output Vishay Semiconductors


Fig. 16 - Turn-on/off Time vs. Forward Current


Fig. 17 - Turn-on/off Time vs. Collector Current

PACKAGE DIMENSIONS in millimeters DIP-6


DIP-6, 400 mil


## PACKAGE MARKING

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