

# Hi-Reliability Optically Coupled Isolator

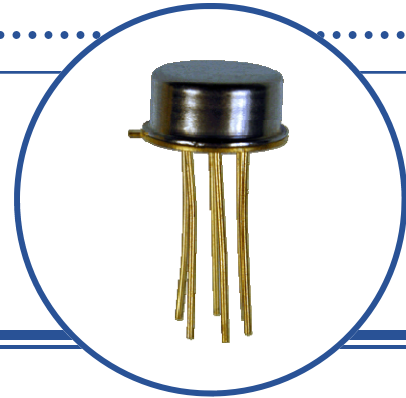
4N22, 4N23, 4N24 [A] (COTS, TX, TXV)

4N47, 4N48, 4N49 [A] (COTS, TX, TXV)



## Features:

- TO-78 hermetically sealed package
- High current transfer ratio
- 1 kV electrical isolation
- Base contact provided for conventional transistor biasing
- TX and TXV devices processed to MIL-PRF-19500
- Patent No. 4124860



## Description:

Each isolator in this series consists of an infrared emitting diode and a NPN silicon phototransistor, which are mounted in a hermetically sealed TO-78 package. Devices are designed for military and/or harsh environments. The suffix letter "A" denotes the collector is electrically isolated from the case.

The 4N22, 4N22A, 4N23, 4N23A, 4N24, and 4N24A (TX, TXV) devices are processed to MIL-PRF-19500/486. The 4N47, 4N47A, 4N48, 4N48A, 4N49, and 4N49A (TX, TXV) devices are processed to MIL-PRF-19500/548.

Please contact your local representative or OPTEK for more information.

## Applications:

- High-voltage isolation between input and output
- Electrical isolation in dirty environments
- Industrial equipment
- Medical equipment
- Office equipment

| Ordering Information |                        |                               |                             |                           |
|----------------------|------------------------|-------------------------------|-----------------------------|---------------------------|
| Part Number          | Isolation Voltage (kV) | I <sub>F</sub> (mA) Typ / Max | V <sub>CE</sub> (Volts) Max | Processing MIL-PRF-195000 |
| 4N22 or 4N22A        | 1                      | 10 / 40                       | 35                          | COTS                      |
| 4N22TX or 4N22ATX    |                        |                               |                             | 486                       |
| 4N22TXV or 4N22ATXV  |                        |                               |                             | COTS                      |
| 4N23 or 4N23A        |                        |                               |                             | 486                       |
| 4N23TX or 4N23ATX    |                        |                               |                             | COTS                      |
| 4N23TXV or 4N23ATXV  |                        |                               |                             | 486                       |
| 4N24 or 4N24A        |                        | 1 / 40                        | 40                          | COTS                      |
| 4N24TX or 4N24ATX    |                        |                               |                             | 486                       |
| 4N24TXV or 4N24ATXV  |                        |                               |                             | COTS                      |
| 4N47 or 4N47A        |                        |                               |                             | 548                       |
| 4N47TX or 4N47ATX    |                        |                               |                             | COTS                      |
| 4N47TXV or 4N47ATXV  |                        |                               |                             | 548                       |
| 4N48 or 4N48A        |                        |                               |                             | COTS                      |
| 4N48TX or 4N48ATX    |                        |                               |                             | 548                       |
| 4N48TXV or 4N48ATXV  |                        |                               |                             | COTS                      |
| 4N49 or 4N49A        |                        |                               |                             | 548                       |
| 4N49TX or 4N49ATX    |                        |                               |                             | COTS                      |
| 4N49TXV or 4N49ATXV  |                        |                               |                             | 548                       |

OPTEK reserves the right to make changes at any time in order to improve design and to supply the best product possible.

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4N22, 4N23, 4N24 [A] (COTS, TX, TXV)

4N47, 4N48, 4N49 [A] (COTS, TX, TXV)



## Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

|                                                                                                                                               |                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Storage Temperature Range<br>4N22, 4N22A, 4N23, 4N23A, 4N24, 4N24A (COTS, TX, TXV)<br>4N47, 4N47A, 4N48, 4N48A, 4N49, 4N49A (COTS, TX, TXV)   | -65° C to +125° C<br>-55° C to +150° C |
| Operating Temperature Range<br>4N22, 4N22A, 4N23, 4N23A, 4N24, 4N24A (COTS, TX, TXV)<br>4N47, 4N47A, 4N48, 4N48A, 4N49, 4N49A (COTS, TX, TXV) | -65° C to +125° C<br>-55° C to +125° C |
| Input-to-Output Isolation Voltage                                                                                                             | $\pm 1.00\text{ kVDC}^{(1)}$           |
| Lead Soldering Temperature [1/16 inch (1.6 mm) from case for 5 seconds with soldering iron]                                                   | 260° C <sup>(2)</sup>                  |

## Input Diode

|                                                                                                                      |                      |
|----------------------------------------------------------------------------------------------------------------------|----------------------|
| Forward DC Current (65° C or below)                                                                                  | 40 mA                |
| Reverse Voltage                                                                                                      | 2 V                  |
| Peak Forward Current (1 $\mu\text{s}$ pulse width, 300 pps)<br>4N22, 4N22A, 4N23, 4N23A, 4N24, 4N24A (COTS, TX, TXV) | 1 A                  |
| Power Dissipation                                                                                                    | 60 mW <sup>(3)</sup> |

## Output Sensor (4N22, 4N22A, 4N23, 4N23A, 4N24, 4N24A )

|                              |                       |
|------------------------------|-----------------------|
| Continuous Collector Current | 50 mA                 |
| Collector-Emitter Voltage    | 35 V                  |
| Collector-Base Voltage       | 35 V                  |
| Emitter-Base Voltage         | 4 V                   |
| Power Dissipation            | 300 mW <sup>(4)</sup> |

## Output Phototransistor (4N47, 4N47A, 4N48, 4N48A, 4N49, 4N49A )

|                              |                       |
|------------------------------|-----------------------|
| Continuous Collector Current | 50 mA                 |
| Collector-Emitter Voltage    | 40 V                  |
| Collector-Base Voltage       | 45 V                  |
| Emitter-Base Voltage         | 7.0 V                 |
| Power Dissipation            | 300 mW <sup>(4)</sup> |

### Notes:

1. Measured with input leads shorted together and output leads shorted together.
2. RMA flux is recommended. Duration can be extended to 10 seconds maximum when flow soldering.
3. Derate linearly 1.0 mW/° C above 65° C.
4. Derate linearly 3.0 mW/° C above 25° C.

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4N22, 4N23, 4N24 [A] (COTS, TX, TXV)

4N47, 4N48, 4N49 [A] (COTS, TX, TXV)



## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

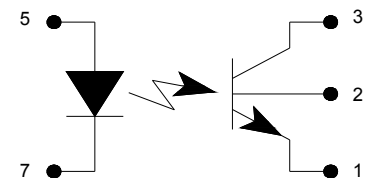
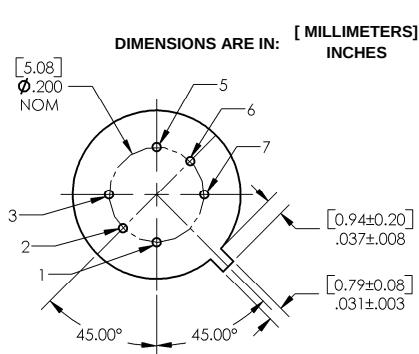
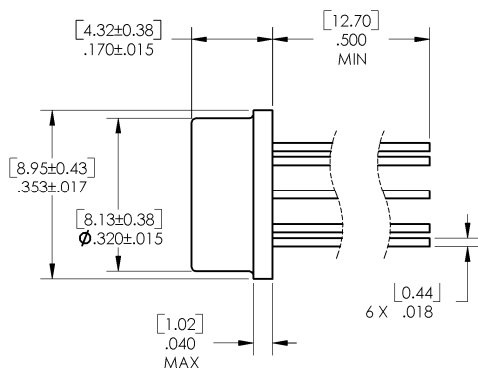
| SYMBOL             | PARAMETER                            | MIN  | TYP | MAX  | UNITS         | TEST CONDITIONS                                        |
|--------------------|--------------------------------------|------|-----|------|---------------|--------------------------------------------------------|
| <b>Input Diode</b> |                                      |      |     |      |               |                                                        |
| $V_F$              | Forward Voltage                      |      |     |      |               |                                                        |
|                    | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 0.80 | -   | 1.30 |               | $I_F = 10.0\text{ mA}$                                 |
|                    | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 1.00 | -   | 1.50 |               | $I_F = 10.0\text{ mA}, T_A = -55^\circ\text{C}^{(1)}$  |
|                    | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 0.70 | -   | 1.20 | V             | $I_F = 10.0\text{ mA}, T_A = -100^\circ\text{C}^{(1)}$ |
|                    | 4N47, 4N48, 4N49 [A] (COTS, TX, TXV) | 0.80 | -   | 1.50 |               | $I_F = 10.0\text{ mA}$                                 |
|                    | 4N47, 4N48, 4N49 [A] (COTS, TX, TXV) | 1.00 | -   | 1.70 |               | $I_F = 10.0\text{ mA}, T_A = -55^\circ\text{C}^{(1)}$  |
|                    | 4N47, 4N48, 4N49 [A] (COTS, TX, TXV) | 0.70 | -   | 1.30 |               | $I_F = 10.0\text{ mA}, T_A = -100^\circ\text{C}^{(1)}$ |
| $I_R$              | Reverse Current                      | -    | -   | 100  | $\mu\text{A}$ | $V_R = 2.0\text{ V}$                                   |

## Output Phototransistor

|               |                                      |    |   |     |    |                                                  |
|---------------|--------------------------------------|----|---|-----|----|--------------------------------------------------|
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage  |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 35 | - | -   | V  | $I_C = 1.0\text{ mA}, I_B = 0, I_F = 0$          |
| $V_{(BR)CBO}$ | Collector-Base Breakdown Voltage     |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 35 | - | -   | V  | $I_C = 100\text{ }\mu\text{A}, I_B = 0, I_F = 0$ |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage       |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | 4  | - | -   | V  | $I_E = 100\text{ }\mu\text{A}, I_C = 0, I_F = 0$ |
| $I_{CEO}$     | Collector-Emitter Dark Current       |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | -  | - | 100 | nA | $V_{CE} = 20\text{ V}, I_B = 0, I_F = 0$         |
| $I_{C(OFF)}$  | Collector-Emitter Dark Current       |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | -  | - | 100 | nA | $V_{CE} = 20\text{ V}, I_B = 0, I_F = 0$         |
| $I_{CB(OFF)}$ | Collector-Base Dark Current          |    |   |     |    |                                                  |
|               | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV) | -  | - | 10  | nA | $V_{CB} = 20\text{ V}, I_E = 0, I_F = 0$         |

### Notes:

1. Guaranteed but not tested.
2. Sample tested, LTPD = 10.



| Pin # | Function  | Pin # | Function |
|-------|-----------|-------|----------|
| 1     | Emitter   | 5     | Anode    |
| 2     | Base      | 6     | Open     |
| 3     | Collector | 7     | Cathode  |

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4N22, 4N23, 4N24 [A] (COTS, TX, TXV)

4N47, 4N48, 4N49 [A] (COTS, TX, TXV)



## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| SYMBOL         | PARAMETER                                                                    | MIN                    | TYP    | MAX    | UNITS         | TEST CONDITIONS                                                                                 |
|----------------|------------------------------------------------------------------------------|------------------------|--------|--------|---------------|-------------------------------------------------------------------------------------------------|
| <b>Coupled</b> |                                                                              |                        |        |        |               |                                                                                                 |
| $I_{C(ON)}$    | On-State Collector Current                                                   |                        |        |        |               |                                                                                                 |
|                | 4N22, 4N22A (COTS, TX, TXV)                                                  | 0.15                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                     |
|                | 4N22, 4N22A (COTS, TX, TXV)                                                  | 2.50                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                    |
|                | 4N22, 4N22A (COTS, TX, TXV)                                                  | 1.00                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$  |
|                | 4N22, 4N22A (COTS, TX, TXV)                                                  | 1.00                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$  |
|                | 4N23, 4N23A (COTS, TX, TXV)                                                  | 0.20                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                     |
|                | 4N23, 4N23A (COTS, TX, TXV)                                                  | 6.00                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                    |
|                | 4N23, 4N23A (COTS, TX, TXV)                                                  | 2.50                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$  |
|                | 4N23, 4N23A (COTS, TX, TXV)                                                  | 2.50                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$  |
|                | 4N24, 4N24A (COTS, TX, TXV)                                                  | 0.40                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                     |
|                | 4N24, 4N24A (COTS, TX, TXV)                                                  | 10.0                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$                                    |
|                | 4N24, 4N24A (COTS, TX, TXV)                                                  | 4.00                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$  |
|                | 4N24, 4N24A (COTS, TX, TXV)                                                  | 4.00                   | -      | -      |               | $I_F = 10.0 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$  |
|                | 4N47, 4N47A (COTS, TX, TXV)                                                  | 0.50                   | -      | -      |               | $I_F = 1.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$                                   |
|                | 4N47, 4N47A (COTS, TX, TXV)                                                  | 0.70                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$ |
|                | 4N47, 4N47A (COTS, TX, TXV)                                                  | 0.50                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$ |
| $I_{CB(ON)}$   | 4N48, 4N48A (COTS, TX, TXV)                                                  | 1.00                   | -      | 5      |               | $I_F = 1.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$                                   |
|                | 4N48, 4N48A (COTS, TX, TXV)                                                  | 1.40                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$ |
|                | 4N48, 4N48A (COTS, TX, TXV)                                                  | 1.00                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$ |
|                | 4N49, 4N49A (COTS, TX, TXV)                                                  | 2.00                   | -      | 10     |               | $I_F = 1.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$                                   |
|                | 4N49, 4N49A (COTS, TX, TXV)                                                  | 2.80                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = -55^\circ\text{C}^{(1)}$ |
|                | 4N49, 4N49A (COTS, TX, TXV)                                                  | 2.00                   | -      | -      |               | $I_F = 2.0 \text{ mA}$ , $V_{CE} = 5.0 \text{ V}$ , $I_B = 0$ , $T_A = 100^\circ\text{C}^{(1)}$ |
| $I_{CB(ON)}$   | On-State Collector Base<br>4N47, 4N48, 4N49 [A] (COTS, TX, TXV)              | 30                     | -      | -      | $\mu\text{A}$ | $V_{CB} = 5 \text{ V}$ , $I_E = 0$ , $I_F = 10 \text{ mA}$                                      |
| $V_{CE(SAT)}$  | Collector-Emitter Saturation Voltage                                         |                        |        |        |               |                                                                                                 |
|                | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV)                                         | -                      | -      | 0.30   |               | $I_F = 20 \text{ mA}$ , $I_C = 2.5 \text{ mA}$ , $I_B = 0$                                      |
|                | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV)                                         | -                      | -      | 0.30   |               | $I_F = 20 \text{ mA}$ , $I_C = 5.0 \text{ mA}$ , $I_B = 0$                                      |
|                | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV)                                         | -                      | -      | 0.30   |               | $I_F = 20 \text{ mA}$ , $I_C = 10.0 \text{ mA}$ , $I_B = 0$                                     |
|                | 4N47, 4N47A (COTS, TX, TXV)                                                  | -                      | -      | 0.30   |               | $I_F = 2.0 \text{ mA}$ , $I_C = 0.5 \text{ mA}$ , $I_B = 0$                                     |
|                | 4N48, 4N48A (COTS, TX, TXV)                                                  | -                      | -      | 0.30   |               | $I_F = 2.0 \text{ mA}$ , $I_C = 1.0 \text{ mA}$ , $I_B = 0$                                     |
|                | 4N49, 4N49A (COTS, TX, TXV)                                                  | -                      | -      | 0.30   |               | $I_F = 2.0 \text{ mA}$ , $I_C = 2.0 \text{ mA}$ , $I_B = 0$                                     |
| $H_{FE}$       | DC Current Gain                                                              |                        |        |        |               |                                                                                                 |
|                | 4N22, 4N22A (COTS, TX, TXV)                                                  | 200                    | -      | -      |               | $V_{CE} = 5.0 \text{ V}$ , $I_C = 10.0 \text{ mA}$ , $I_F = 0 \text{ mA}$                       |
|                | 4N23, 4N23A (COTS, TX, TXV)                                                  | 300                    | -      | -      |               | $V_{CE} = 5.0 \text{ V}$ , $I_C = 10.0 \text{ mA}$ , $I_F = 0 \text{ mA}$                       |
|                | 4N24, 4N24A (COTS, TX, TXV)                                                  | 400                    | -      | -      |               | $V_{CE} = 5.0 \text{ V}$ , $I_C = 10.0 \text{ mA}$ , $I_F = 0 \text{ mA}$                       |
|                | 4N47, 4N48, 4N49 [A] (COTS, TX, TXV)                                         | 100                    | -      | -      |               | $V_{CE} = 5.0 \text{ V}$ , $I_C = 10.0 \text{ mA}$ , $I_F = 0 \text{ mA}$                       |
| $R_{IO}$       | Resistance (Input-to-Output)                                                 |                        |        |        |               |                                                                                                 |
|                | 4N22, 4N23, 4N24 [A] (COTS, TX, TXV)<br>4N47, 4N48, 4N49 [A] (COTS, TX, TXV) | $10^{11}$<br>$10^{11}$ | -<br>- | -<br>- | $\Omega$      | $V_{IO} = \pm 1.0 \text{ VDC}^{(3)}$<br>$V_{I-O} = \pm 1000 \text{ VDC}^{(3)}$                  |
| $C_{IO}$       | Capacitance (Input-to-Output)                                                | -                      | -      | 5      | pF            | $V_{I-O} = 0 \text{ V}$ , $f = 1.0 \text{ MHz}^{(3)}$                                           |

### Notes:

1. Guaranteed but not tested.
2. Sample tested, LTPD = 10.
3. Measured with input leads shorted together and output leads shorted together.

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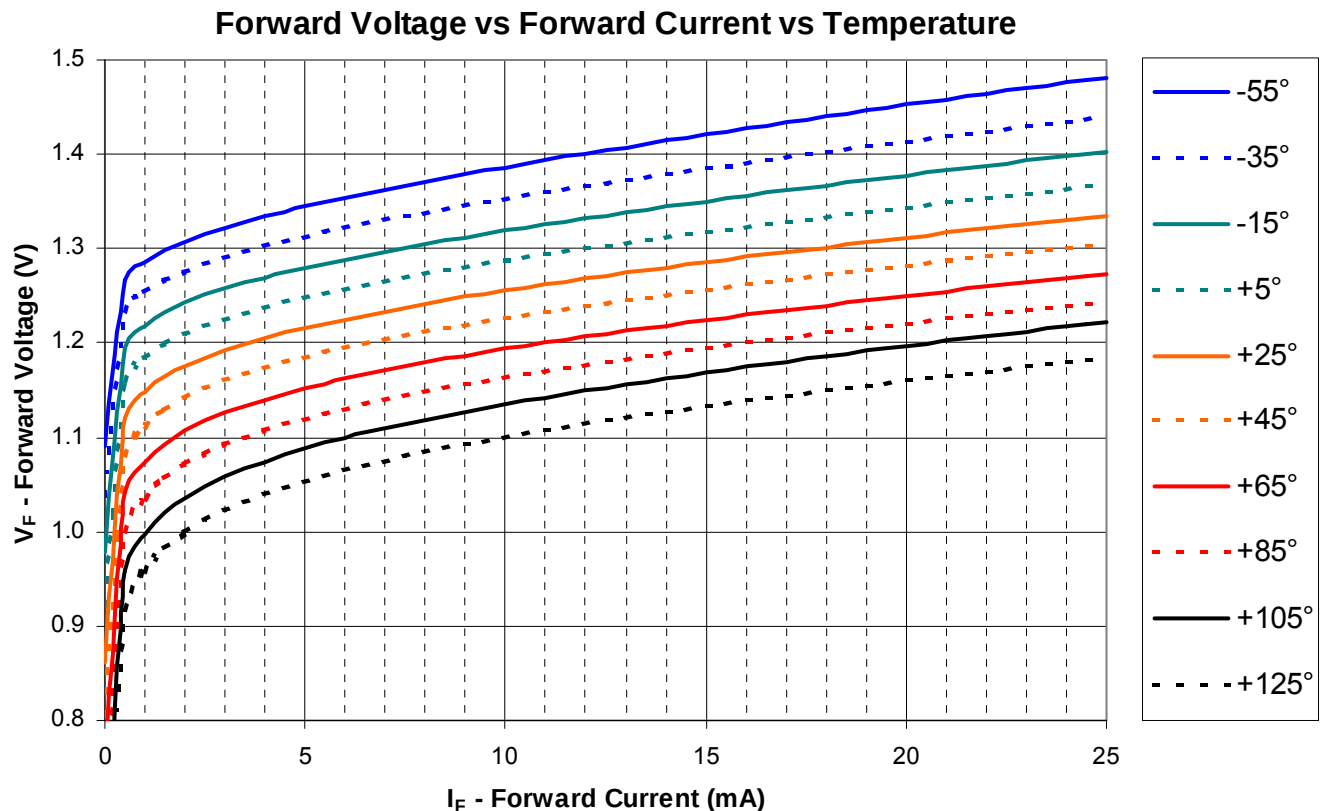
4N47, 4N48, 4N49 [A] (COTS, TX, TXV)



## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| SYMBOL         | PARAMETER        | MIN | TYP | MAX | UNITS         | TEST CONDITIONS                                                               |
|----------------|------------------|-----|-----|-----|---------------|-------------------------------------------------------------------------------|
| <b>Coupled</b> |                  |     |     |     |               |                                                                               |
| $T_R$          | Output Rise Time | -   | -   | 15  | $\mu\text{s}$ | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ mA}$     |
|                | 4N22A (TX, TXV)  | -   | -   | 15  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ mA}$     |
|                | 4N23A (TX, TXV)  | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ mA}$     |
|                | 4N24A (TX, TXV)  | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |
|                | 4N47 (TX, TXV)   | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |
|                | 4N48 (TX, TXV)   | -   | -   | 25  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |
| $T_F$          | Output Fall Time | -   | -   | 15  | $\mu\text{s}$ | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ }\Omega$ |
|                | 4N22A (TX, TXV)  | -   | -   | 15  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ }\Omega$ |
|                | 4N23A (TX, TXV)  | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 10.0\text{ mA}$ , $R_L = 100\text{ }\Omega$ |
|                | 4N24A (TX, TXV)  | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |
|                | 4N47 (TX, TXV)   | -   | -   | 20  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |
|                | 4N48 (TX, TXV)   | -   | -   | 25  |               | $V_{CC} = 10.0\text{ V}$ , $I_F = 5.0\text{ mA}$ , $R_L = 100\text{ }\Omega$  |

## Typical Performance Curves



OPTEK reserves the right to make changes at any time in order to improve design and to supply the best product possible.

# Hi-Reliability Optically Coupled Isolator

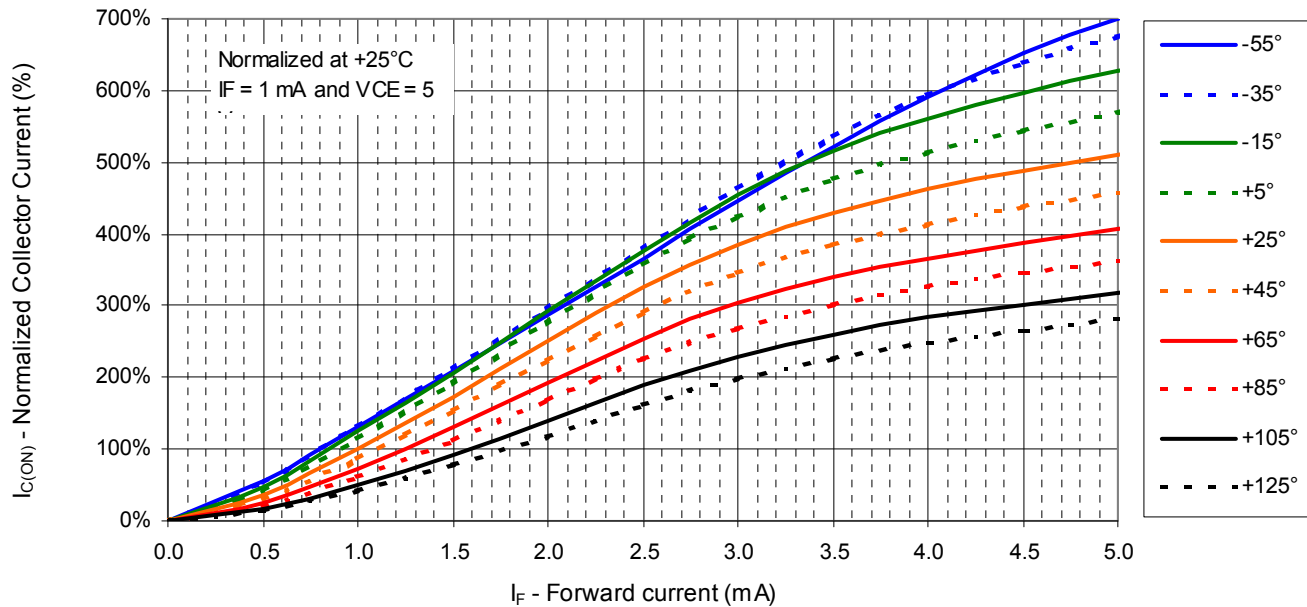
4N22, 4N23, 4N24 [A] (COTS, TX, TXV)

4N47, 4N48, 4N49 [A] (COTS, TX, TXV)

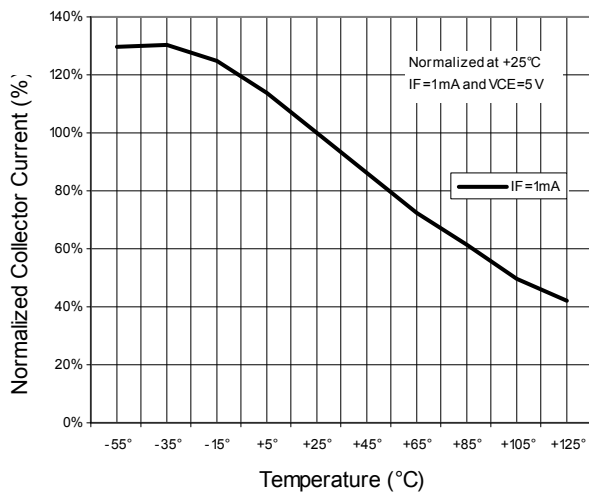


## Typical Performance Curves

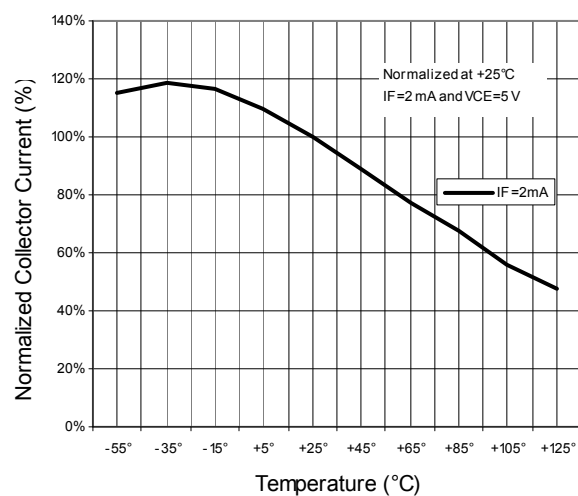
Collector Current vs Forward Current vs Temperature



Normalized Collector Current Vs Temperature



Normalized Collector Current Vs Temperature



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