

# ENX GAMA

## Product Information



**TABLE OF CONTENTS**

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>TECHNICAL DATA</b>                          | <b>4</b>  |
|          | 1.1 Absolute Maximum Rating .....              | 4         |
|          | 1.2 General Data .....                         | 4         |
|          | 1.3 Incremental Interface (single-ended) ..... | 4         |
|          | 1.4 Angle Measurement .....                    | 5         |
|          | 1.5 Dimensional Drawings .....                 | 5         |
| <b>2</b> | <b>DEFINITIONS</b>                             | <b>6</b>  |
| <b>3</b> | <b>ADDITIONAL INFORMATION</b>                  | <b>8</b>  |
|          | 3.1 Compliance to Regulations .....            | 8         |
|          | 3.2 Radiation Resistance .....                 | 8         |
|          | 3.3 Preconditions for operation .....          | 8         |
| <b>4</b> | <b>PIN ASSIGNMENT</b>                          | <b>9</b>  |
|          | 4.1 Standard cable plug 10pole .....           | 9         |
|          | 4.2 Optional cable plug 6pole .....            | 10        |
| <b>5</b> | <b>OUTPUT CIRCUITRY</b>                        | <b>11</b> |

## ENX GAMA Encoders – Product Information



Figure 1 Top: ENX 10 GAMA alone and assembled on RE 10  
Bottom: ENX 13 GAMA alone and assembled on DC-max 16

The compact maxon ENX GAMA Encoders use magneto resistive sensors (AMR sensor) to generate incremental square wave signals. The resolution is 12 impulses (ENX 10 GAMA) or 16 impulses (ENX 13 GAMA). Available are two channels (A and B, single-ended).

The axially arranged connection cable is designed as a single cable system and integrates the two motor cables on the attached DC motor. The ENX GAMA Encoders can be combined with various DC motors from the maxon product range. They feature ESD protection and are available with various cable lengths and different connectors.

The ENX GAMA Encoders are radiation-resistant. They can be utilized in environments exposed to ionizing radiation and are resistant to a radiation dose (TID) of up to 500 krad (SiO<sub>2</sub>).



### Note

*The listed data are for informational purposes only. The values or specifications given are intended as an indicator and may differ from the effective performance.*

## 1 TECHNICAL DATA

### 1.1 Absolute Maximum Rating

| Parameter                                 | Conditions                 | Min  | Max            | Unit |
|---|----------------------------|------|----------------|------|
| Supply voltage ( $V_{CC}$ )               |                            | -0.5 | +9.0           | V    |
| Voltage at signal output ( $V_{signal}$ ) |                            | -0.5 | $V_{CC}-0.1$ V | V    |
| ESD voltage ( $V_{ESD}$ )                 | all pins                   |      | >8             | kV   |
| Operating temperature ( $T_{amb}$ )       |                            | -20  | +105           | °C   |
| Storage temperature ( $T_{store}$ )       |                            | -20  | +105           | °C   |
| Humidity                                  | condensation not permitted | 20   | 85             | %rH  |

### 1.2 General Data

| Parameter                   | Conditions | Min  | Typ | Max  | Unit |
|-----------------------------|------------|------|-----|------|------|
| Supply voltage ( $V_{CC}$ ) |            | +4.5 | +5  | +5.5 | V    |
| Supply current ( $I_{DD}$ ) |            |      | 9.5 |      | mA   |

### 1.3 Incremental Interface (single-ended)

| Parameter                              | Conditions   | Min | Typ | Max | Unit    |
|--|--|-----|-----|-----|---------|
| Number of channels                     | ChA, ChB   |     | 2   |     | –       |
| Counts per turn (N)                    | ENX 10 GAMA  |     | 12  |     | cpt     |
|  | ENX 13 GAMA  |     | 16  |     |         |
| Pulse frequency ( $f_{pulse}$ )        | Maximum output pulse frequency   |     | 24  |     | kHz     |
| Signal output current ( $I_{signal}$ ) |  | -10 |     | +10 | mA      |
| Transition time ( $t_{trans}$ )        | Rise time/fall time ChA/ChB without load, $R_{DIFF} = 1'000 \Omega$ , $CD = 50$ pF |     | 3   |     | $\mu$ s |

## 1.4 Angle Measurement

*Conditions* All values at  $T = 25^{\circ}\text{C}$ ,  $n = 5'000\text{ rpm}$ ,  $V_{cc} = 5\text{ V}$  unless otherwise specified.

*Definitions* See →page 6.

| Parameter   | Conditions   | Min      | Typ         | Max        | Unit |
|---|--|----------|-------------|------------|------|
| Counting direction of incremental signals (Dir)   | Motor shaft movement for signal phase alignment "A leads B" as seen from the shaft end |          | CW          |            | —    |
| Integral Nonlinearity (INL)                       | ENX 10 GAMA: N = 12 cpt<br>ENX 13 GAMA: N = 16 cpt                                     |          | 3<br>2      | 6<br>5     | °m   |
| Differential Nonlinearity (DNL) [a]               | ENX 10 GAMA: N = 12 cpt<br>ENX 13 GAMA: N = 16 cpt                                     |          | 0.2<br>0.15 | 0.5<br>0.5 | LSB  |
| Repeatability (Jitter), incremental signals       |  |          | 0.01        | 0.1        | LSB  |
| Phase delay A to B (Phase $\theta$ ), incremental | ENX 10 GAMA: N = 12 cpt<br>ENX 13 GAMA: N = 16 cpt                                     | 70<br>80 |             | 110<br>100 | °e   |
| Duty cycle per channel                            |  | 40       |             | 60         | %    |

[a] Measurement results from laboratory characterization.

## 1.5 Dimensional Drawings

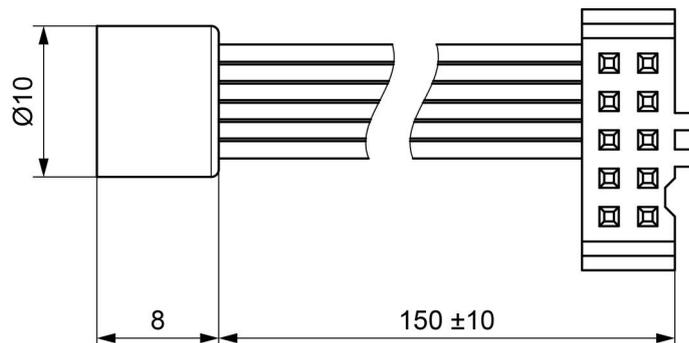


Figure 2 ENX 10 GAMA – Dimensional drawing [mm]

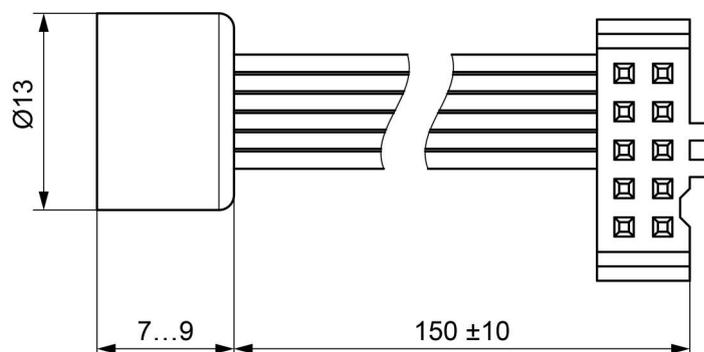


Figure 3 ENX 13 GAMA – Dimensional drawing [mm]

## 2 DEFINITIONS

| Metric                               | Definition  | Illustration |
|--------------------------------------|---|--------------|
| Angle Error [°m]                     | Difference of measured and true angular shaft position at each position.  |              |
| Average Angle Error [°m]             | Average of Angle Error at each position, over a given number of turns.  |              |
| Integral Nonlinearity (INL) [°m]     | Peak-to-peak value of Average Angle Error.  |              |
| Jitter (Repeatability) [°m] or [LSB] | Six standard deviations of Angle Error per turn (at each position, over a given number of turns).<br><b>Jitter [°m]</b> is typically independent of the resolution and defines the maximum useful positioning repeatability.<br><b>Jitter [LSB]</b> is resolution-dependent. At given Jitter [°m], the value is roughly proportional to resolution. |              |
| Least Significant Bit (LSB)          | Minimum measurable difference between two angle values at given resolution (= quadcount, = State).  |              |
| State Error [LSB]                    | Difference between actual state length and average state length.  |              |
| Average State Error [LSB]            | Average of State Error over a number of turns for each state of a turn.   |              |
| Differential Nonlinearity [DNL]      | Maximum positive or negative Average State Error.   |              |
| Minimum State Length [°e]            | Minimum measured state length within a number of turns relative to pulse length.  |              |
| Maximum State Length [°e]            | Maximum measured state length within a number of turns relative to pulse length.  |              |
| Minimum State Duration [ns]          | By chip limited minimum time separation between two A/B transitions.  |              |

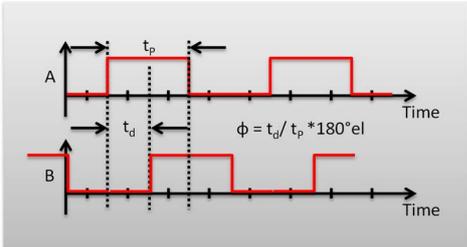
| Metric                    | Definition   | Illustration   |
|---------------------------|--|--|
| Phase delay $\theta$ [°e] | Time difference of rising edge A to B relative to duration of positive level of A. |  <p>The illustration shows two square wave signals, A and B, plotted against Time. Signal A is a pulse with a duration labeled <math>t_p</math>. Signal B is a pulse that starts later than signal A, with the time difference between their rising edges labeled <math>t_d</math>. The phase delay <math>\phi</math> is defined by the equation <math>\phi = t_d / t_p * 180^\circ \text{el}</math>.</p> |
| Duty cycle [%]            | Ratio of the state duration of the positive level to the pulse length.             |  |

Table 1

Definitions

### 3 ADDITIONAL INFORMATION

#### 3.1 Compliance to Regulations

| Parameter   | Description  |
|---|--|
| Electrostatic discharge immunity (DIN EN 61000-4-2) | Direct discharge on input/output pins– $\pm 8$ kV.   |
| Mean Time Between Failure (MTBF)                    | (MIL-HDBK-217F, Ground Benign GB, 25°C, In accordance with circuit diagram and nominal power) <ul style="list-style-type: none"> <li>• ENX 10 GAMA: 28'694'120 hrs</li> <li>• ENX 13 GAMA: 66'915'425 hrs</li> </ul> |

Table 2 Compliance to regulations

#### 3.2 Radiation Resistance

A special feature of the ENX GAMA Encoders is their radiation-resistant. They can be utilized in environments exposed to ionizing radiation and are resistant to a radiation dose (TID) of up to 500 krad (SiO<sub>2</sub>).

The radiation resistance was determined based on type measurements and by means of «Total Ionizing Dose (TID) Tests». These tests were performed at a Cobalt-Co60 radiation source and at an applied dose rate of up to 18 krad (SiO<sub>2</sub>)/h.

#### 3.3 Preconditions for operation



##### **Preconditions for trouble-free operation**

- *The encoder already reacts to small and medium magnetic fields. For best performance, no magnetic fields must be present in the encoder's immediate vicinity.*
- *The supply voltage ( $V_{CC}$ ) must be within the specified range.*

## 4 PIN ASSIGNMENT



### Maximum permitted Supply Voltage

- Supply voltages exceeding the stated range will destroy the unit.
- Connect the unit only when the supply voltage is switched off ( $V_{CC}=0$ ).



### Load capacity of connection cables

- The maximum permissible continuous current of the cable and plug is 1.2 A (at an ambient temperature of 25 °C).
- The connection cable has no strain relief and must not be subject to excessive tensile forces.

### 4.1 Standard cable plug 10pole

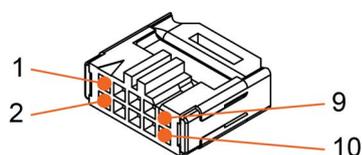


Figure 4 Cable plug 10pole

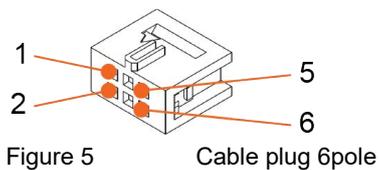
| Pin | Signal     | Description          |
|-----|------------|----------------------|
| 1   | Motor (+M) | Motor +              |
| 2   | VCC        | Power supply voltage |
| 3   | Ch A       | Channel A            |
| 4   | Ch B       | Channel B            |
| 5   | GND        | Ground               |
| 6   | Motor (-M) | Motor -              |
| 7   | -          | not connected        |
| 8   | -          | not connected        |
| 9   | -          | not connected        |
| 10  | -          | not connected        |

Table 3 Cable plug 10pole – Pin Assignment

| Specifications |  |
|----------------|--|
| Connector      | IDC socket, pitch 2.54 mm, 5 x 2 poles                         |
| Mating plug    | Pin header, pitch 2.54 mm, 5 x 2 poles (EN 60603-13/DIN 41651) |

Table 4 Cable plug 10pole – Specifications

## 4.2 Optional cable plug 6pole



| Pin | Signal     | Description          |
|-----|------------|----------------------|
| 1   | Motor (+M) | Motor +              |
| 2   | VCC        | Power supply voltage |
| 3   | Ch A       | Channel A            |
| 4   | Ch B       | Channel B            |
| 5   | GND        | Ground               |
| 6   | Motor (-M) | Motor -              |

Table 5 Cable plug 6pole – Pin Assignment

| Specifications |  |
|----------------|--|
| Connector      | IDC socket, pitch 2.54 mm, 3 x 2 poles                         |
| Mating plug    | Pin header, pitch 2.54 mm, 3 x 2 poles (EN 60603-13/DIN 41651) |

Table 6 Cable plug 6pole – Specifications

## 5 OUTPUT CIRCUITRY

In general, a high impedance network with cable lengths <1 m is recommended (signals are single-ended).

The encoder can be loaded with up to 10 mA per channel (@5 V, R = 500 Ω). The integrated push-pull circuit generates TTL compatible output signals.

Pull-up/pull-down resistors are permitted but not mandatory. If they are used, it must be ensured that the current per channel is limited to <10 mA.

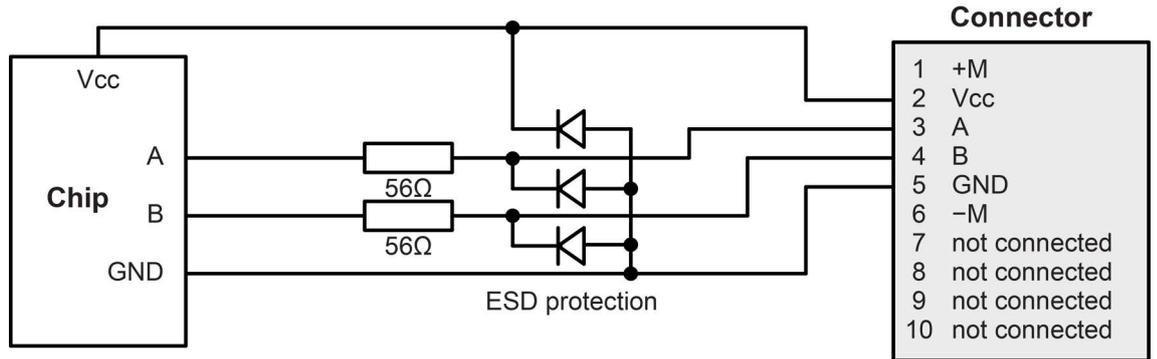


Figure 6 Signal output with line matching with 56 Ohm and ESD protection circuitry

