maxon

ENX EMT

Product Information

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ENX EMT Encoders – Product Information

Figure 1 ENX 22 EMT

The absolute multiturn encoder «ENX EMT» offers very high resolutions of 16 bit (multiturn) and up to 17 bit (singleturn) in a very small space. The Wiegand wire technology enables an energy-autonomous supply of the encoder in multiturn operation. A buffer battery or a complex gearbox are thus dispensable.

The encoder is available with certified BiSS-C and with SSI interface and can be combined with various motors and drives from maxon's product range.

Note

The listed data are for informational purposes only. None of the stated values or information may be used as an indicator of guaranteed performance.

1 TECHNICAL DATA

1.1 Absolute Maximum Rating

Parameter	Conditions	Min	Max	Unit
Voltage at signal output (V_{signal})		–0.3	+6.0	V
Signal output current (I_{signal})	DATA, DATA\; no supply voltage	–250	+250	mA
Operating temperature (T_{amb})		–40	+105	°C
Storage temperature (T_{store})		–40	+115	°C
Humidity (condensation not permitted)			90	%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})	no load		60		mA
	Termination resistor differential Data-Data\ = 120 Ω	80	90	100	
Max. speed	Electrical limit for characteristic values			12'000	rpm

1.3 Absolute Interface

Parameter	Conditions	Min	Typ	Max	Unit
Max. number of turns	16 bit			65'536	—
Steps per turn (ST)	17 bit			131'072	—
Signal output current (I_{signal})	DATA output: Termination resistor differential Data-Data\ = 120 Ω	–60		+60	mA
Signal voltage high (V_{high})	DATA output: I_{signal} <60 mA	2.5			V
Signal voltage low (V_{low})	DATA output: I_{signal} <60 mA			0.4	V
Transition time (t_{trans})	DATA output: Rise time/fall time, C_{load} = 50 pF			10	ns
CLK Signal Frequency (f_{clk}) [a]	SSI mode	0.3		1	MHz
	BiSS mode	0.08		5	MHz
Timeout (t_{out}) (➔Figure 4)	SSI mode			7	µs
	BiSS mode with line delay compensation			18	µs
Busytime (tbusy) (➔Figure 5)	BiSS mode	6.5	7.5	8	µs
Permissible input voltage CLK, CLK\ (V_{in})	SSI/BiSS mode	–7.5		+12	V
Input resistance differential CLK-CLK/ (R_t)			112		Ω

[a] *Used as a commutation sensor, the CLK signal frequency also influences the quality of the commutation via the data rate. A high as possible CLK frequency improves the quality of the commutation.*

1.4 Angle Measurement

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

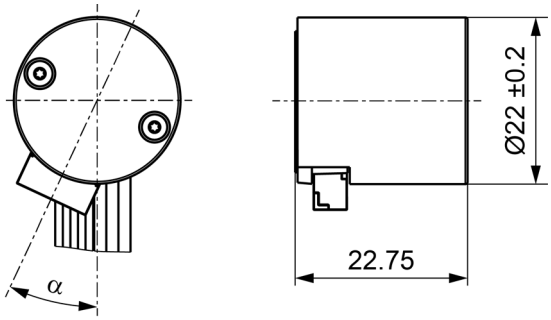
Definitions *See ➔page 8.*

Parameter	Conditions	Min	Typ	Max	Unit
Counting direction of absolute signals (Dir)	Motor shaft movement for increasing angle values as seen from the shaft end		CW		
Integral Nonlinearity (INL)	All number of impulses		<1		°m
Repeatability (Jitter), ±3σ noise level			0.02		°m
	Length of the data word: 17 bit		7		LSB
Noise-free resolution, ±3σ noise level	Maximum number of bits unaffected by peak-to-peak noise		14		bit
Angle hysteresis (Hyst)			0		°m

Preconditions for trouble-free operation
Voltage ripples (V_{pp}) in the supply voltage (V_{cc}) with an amplitude ≥100 mV affect the repeatability of the encoder.

1.5 Mechanical Data

Parameter	Conditions	Value	Unit
Dimensions (D x L) (➔Figure 2)	ENX 22 EMT	Ø22 x 22.75	mm
Moment of inertia (Jt)	motor shaft Ø2, 3, 4 mm	154	g cm²



The angle «α» between encoder connector and motor cable outlet is unique for a particular combination and cannot be selected. The exact angle is given in the dimensional drawing of the respective combination.

Figure 2 ENX 22 EMT – Dimensional drawing

1.6 Angle Alignment

The angle value “zero” of the absolute encoder (singleturn) is factory-programmed to the commutation angle “zero” of the used EC (BLCD) motor (➔Figure 3).

- When assembled onto a motor with several pole pairs (n), the absolute encoders (singleturn) will show the angle value “zero” **once per mechanical turn**.
- Due to its multiple sets of pole pairs, the **motor** will show this commutation angle **n times per mechanical turn**.

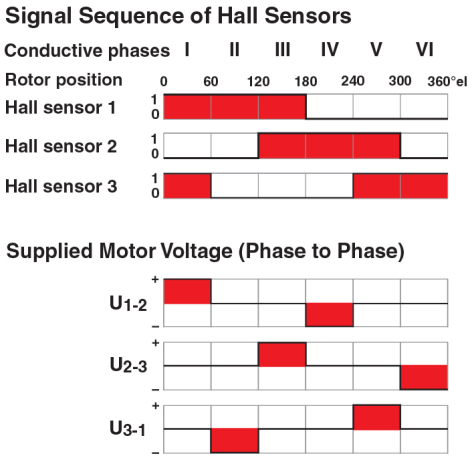


Figure 3 Block Commutation of EC (BLDC) Motors – Definition of Phases

2 ABSOLUTE ENCODER

The «ENX EMT» encoders provide the functionality of an absolute encoder with both Singleturn and Multiturn functionality. Two interface protocol variants are factory-configurable; SSI and BiSS-C.

2.1 SSI Mode

- The wait time after reading of last bit must be larger than the Timeout (t_{out}).
- Data frame: n=8 start bits (value 0) + 16 Multiturn bits + 17 Singleturn bits
- A complete reading cycle takes at least 50 µs.

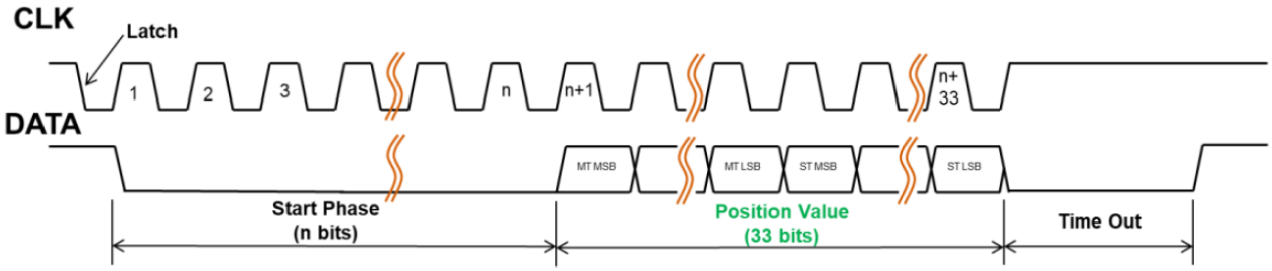


Figure 4 Timing of ENX EMT in SSI Mode

2.2 BiSS-C Mode

- The wait time after reading of last bit must be larger than the Timeout (t_{out}).
- Data frame: start sequence {Ack, Start, CDS}, 16 Multiturn bits, 17 Singleturn bits, 2 error/warning bits, 6 CRC bits
- A complete reading cycle at maximum clock rate takes at least as follows:

$$t_{busy} + 43 \cdot \frac{1}{fclk} + t_{out}$$

- The interface is BiSS-C-compatible. Find more information on the BiSS-C interface specification here: ➔https://www.posital.com/; section “Kit Encoder/On-axis”

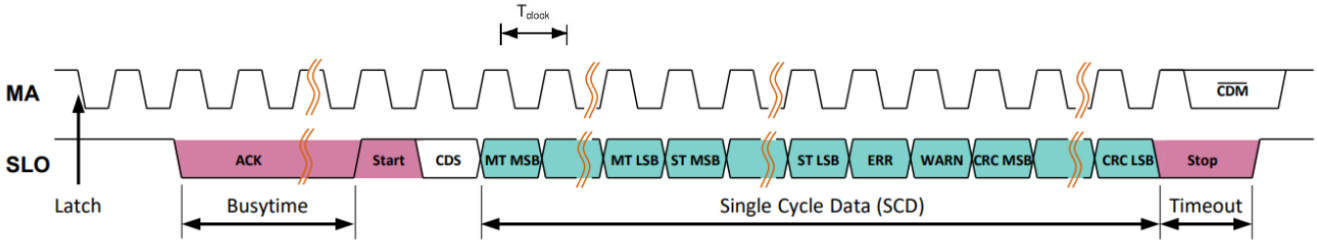


Figure 5 Timing of ENX EMT in BiSS-C Mode

3 DEFINITIONS

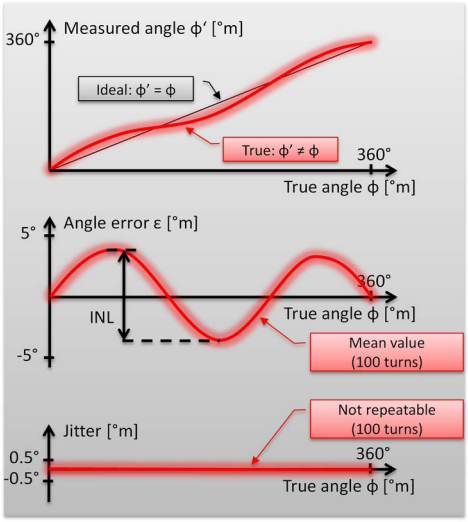
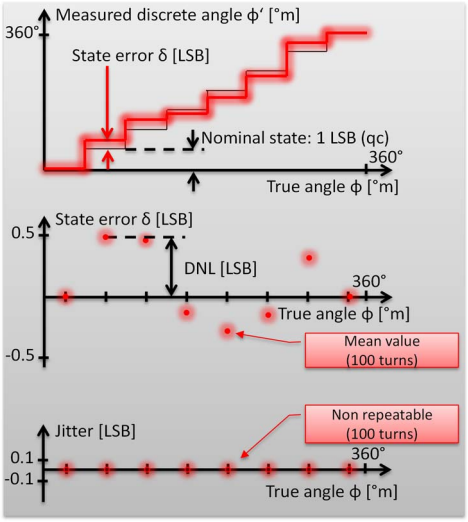
Metric	Definition	Illustration
Angle Error [°m]	Difference of measured and true angular shaft position at each position.	
Average Angle Error [°m]	Average of Angle Error at each position, over a given number of turns.	
Integral Nonlinearity (INL) [°m]	Peak-to-peak value of Average Angle Error.	
Jitter (Repeatability) [°m] or [LSB]	Six standard deviations of Angle Error per turn (at each position, over a given number of turns). **Jitter [°m]** is typically independent of the resolution and defines the maximum useful positioning repeatability. **Jitter [LSB]** is resolution-dependent. At given Jitter [°m], the value is roughly proportional to resolution.	
Noise-free resolution	Maximum number of bits unaffected by peak-to-peak noise	
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.	

Table 1 Definitions

4 TYPICAL MEASUREMENT RESULTS

4.1 Angle Error per Turn

Below graph shows exemplary the angle error of an EMT encoder.
Conditions: Measurement of 25 turns at V_{cc}=5 V, n=5'000 rpm, T=25°C, resolution 17 bit

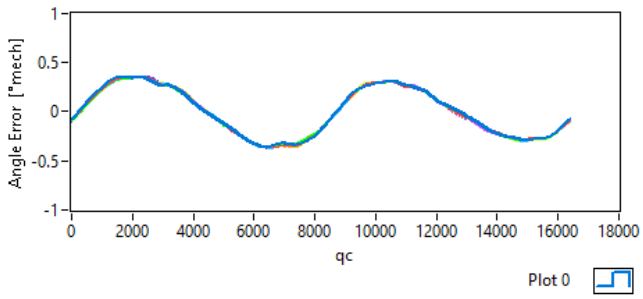
Resolution	Graph	Analysis	
17 bit		INL	0.6°m

Table 2 Typical Measurement Results

4.2 Jitter

Figure 6 shows the random portion of the angular error measured at a standstill position. Six standard deviations (σ) of the value sequence can typically reach 7 LSB.
Conditions: V_{cc}=5 V, n=0 rpm, T=25°C, 120 Ω load, resolution 17 bit (1 LSB = 0.0027 °m)

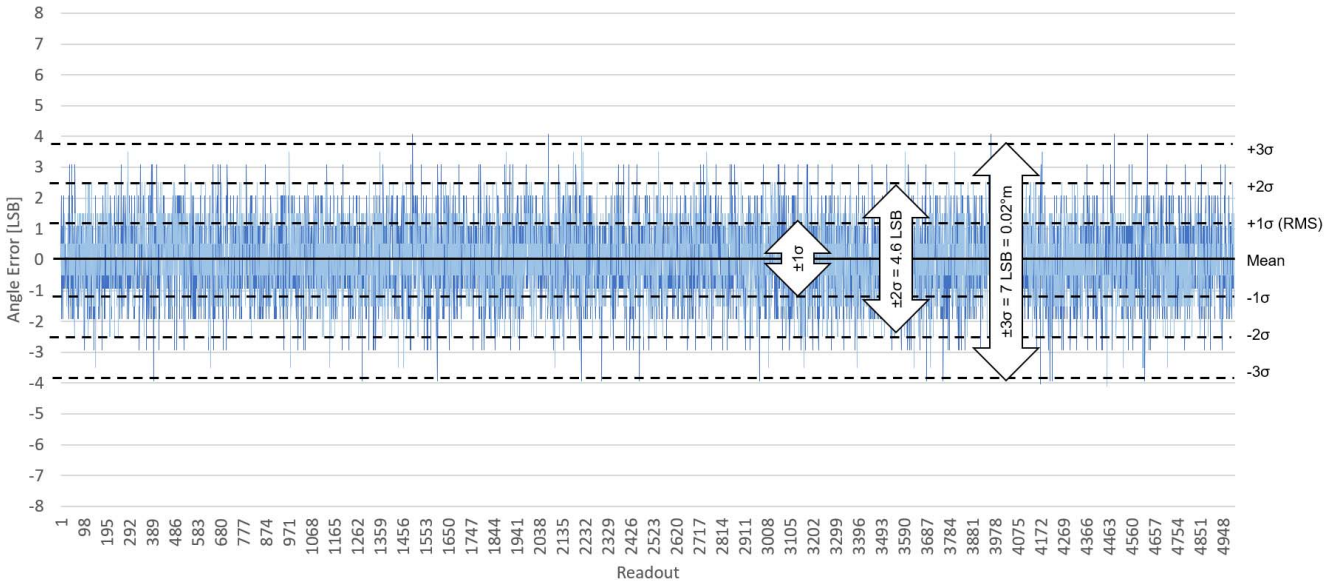


Figure 6 Jitter

4.3 Temperature Dependence

The INL is essentially independent of temperature.

Figure 7 shows the temperature dependence of 10 different EMT encoders.
Conditions: V_{cc}=5 V, n=5'000 rpm, 120 Ω load, resolution 17 bit

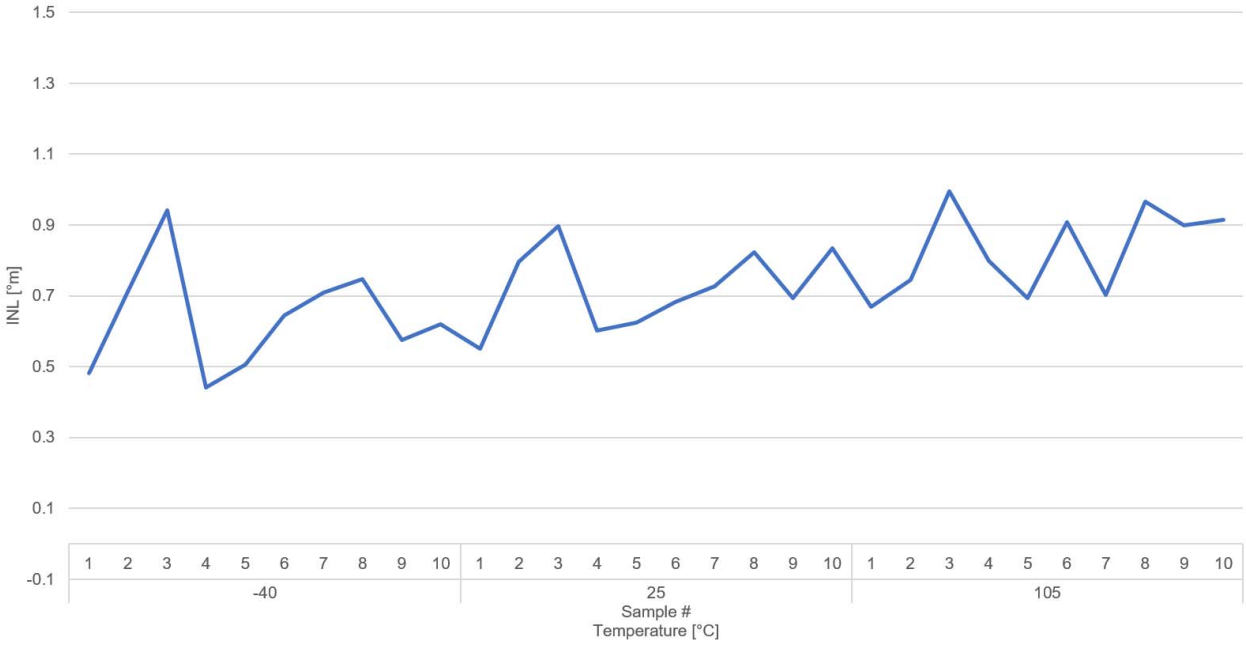


Figure 7 Temperature Dependence INL

The noise is temperature-dependent. At 105°C, values are to be expected about twice as high as at room temperature.

Figure 8 shows the temperature dependence of 10 different EMT encoders.
Conditions: V_{cc}=5 V, n=0 rpm, 120 Ω load, resolution 17 bit

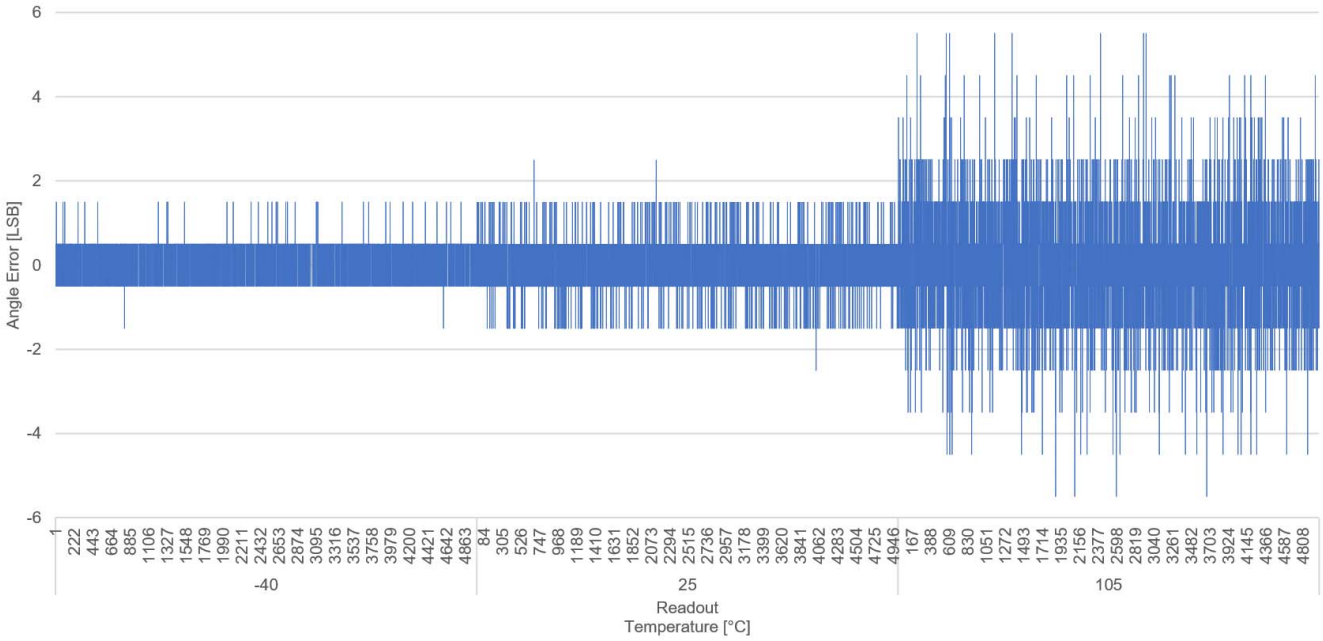


Figure 8 Temperature Dependence Jitter

4.4 Compliance to Regulations

Parameter	Description
Electrostatic discharge immunity (DIN EN 61000-4-2)	Direct discharge on conductive surfaces – ±8 kV. Direct discharge on non-conductive surfaces – ±15 kV.
Vibration strength (DIN EN 60068-2-64)	Environmental testing – ≤3.4 g (sinusoidal, 10…1'000 Hz; T_{amb} 25°C)
Shock resistance (DIN EN 60068-2-27)	Environmental testing – ≤50 g (semi-sinusoidal, 11 ms; T_{amb} 25°C)
Mean Time To Failure (MTTF)	@105°C: 36 years
Compatibility UL	See conditions listed below

Table 3 Compliance to regulations

The following conditions are fulfilled by the product or must be fulfilled in the customer's overall system in order to have a drive unit equipped with an ENX 22 EMT encoder certified according to UL:

- As per UL 840 chapter 8:
  The encoder is considered as “low voltage equipment” because it has a supply voltage below 50 V and all electrically conducting parts are separated by at least 0.2 mm from the next adjacent metal part that is or could be electrically connected to an outside potential.
- As per UL 746C chapter 3.34 section b:
  The maximum power consumption of the device is less than 15 W. The voltage supply must guarantee that, even in case of defect of at the encoder, the maximum power consumption is limited to 15 W (for example by current limiting circuitry).
- A surrounding system with circuitry operating at voltages between 50 V and 125 V must either guarantee an isolation distance of at least 1.6 mm between all parts at the voltages and the encoder or such conductors must use UL-listed isolations.

5 PIN ASSIGNMENT

Maximum permitted Supply Voltage

- *Make sure that supply power is within stated range.*
- *Supply voltages exceeding the stated range—or wrong polarity—will destroy the unit.*
- *Connect the unit only when supply voltage is switched off (V_{CC}=0).*

ENX EMT

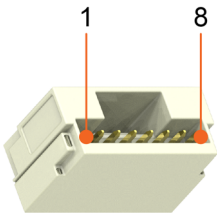


Figure 9 ENX EMT – Cable Plug

Pin	Signal	Description
1	GND	Ground
2	—	do not connect (“Preset” [b])
3	—	do not connect (“Config” [b])
4	Data+/SLO+	Absolute encoder Data
5	Data–/SLO–	Absolute encoder Data complement
6	CLK–/MA–	Absolute encoder Clock complement
7	CLK+/MA+	Absolute encoder Clock
8	V_{cc}	Power supply voltage

[b] The functionality is not included in the scope of delivery. However, you can – on your own responsibility – make use of it whereby maxon does not assume any responsibility or liability. Find more details here: ➔https://www.posital.com/; section “Kit Encoder/On-axis”

Table 4 ENX EMT – Pin Assignment

Cable Plug ENX EMT	
Connector	JST BM08B-NSHSS-TBT
Mating plug	JST NSHR-08V-S

Table 5 ENX EMT – Specifications Cable Plug

6 OUTPUT CIRCUITRY

The following figure shows the conceptual output schematics.

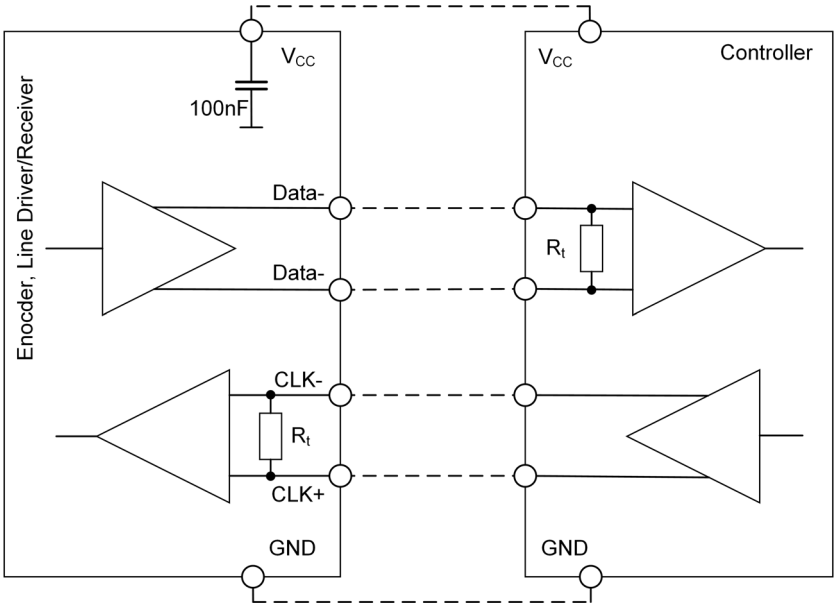


Figure 10 ENX EMT – Output Circuitry

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