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The Technology Company

AMP

Hollow Shaft Resolver

Tyco Electronics
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Content

Hollow Shaft Resolver

General Description

The use of sensors for determining angles increases with progressive automation. The hollow shaft resolver has long won its own steady position on the market and can nowadays be found in many modern, high-precision control systems.

Due to its design, the hollow shaft resolver boasts of a service live above average. Reliability as well as high precision and low space requirements supplement its favorable characteristics. It remains fully operable even under extreme environmental conditions.

Essentially, the resolver mechanically consists of a stationary stator and a movable rotor. Electrically it consists of of a transformer for supplying the rotor with power and a second transformer for determining angles.

The first transformer has a concentric design and is functionally independent of angle values. The second, angle-dependent transformer is made of a stator winding and a rotor winding. The windings of these two transformer components are designed such that the number of windings in the grooves correspond to the values of a sinoid.

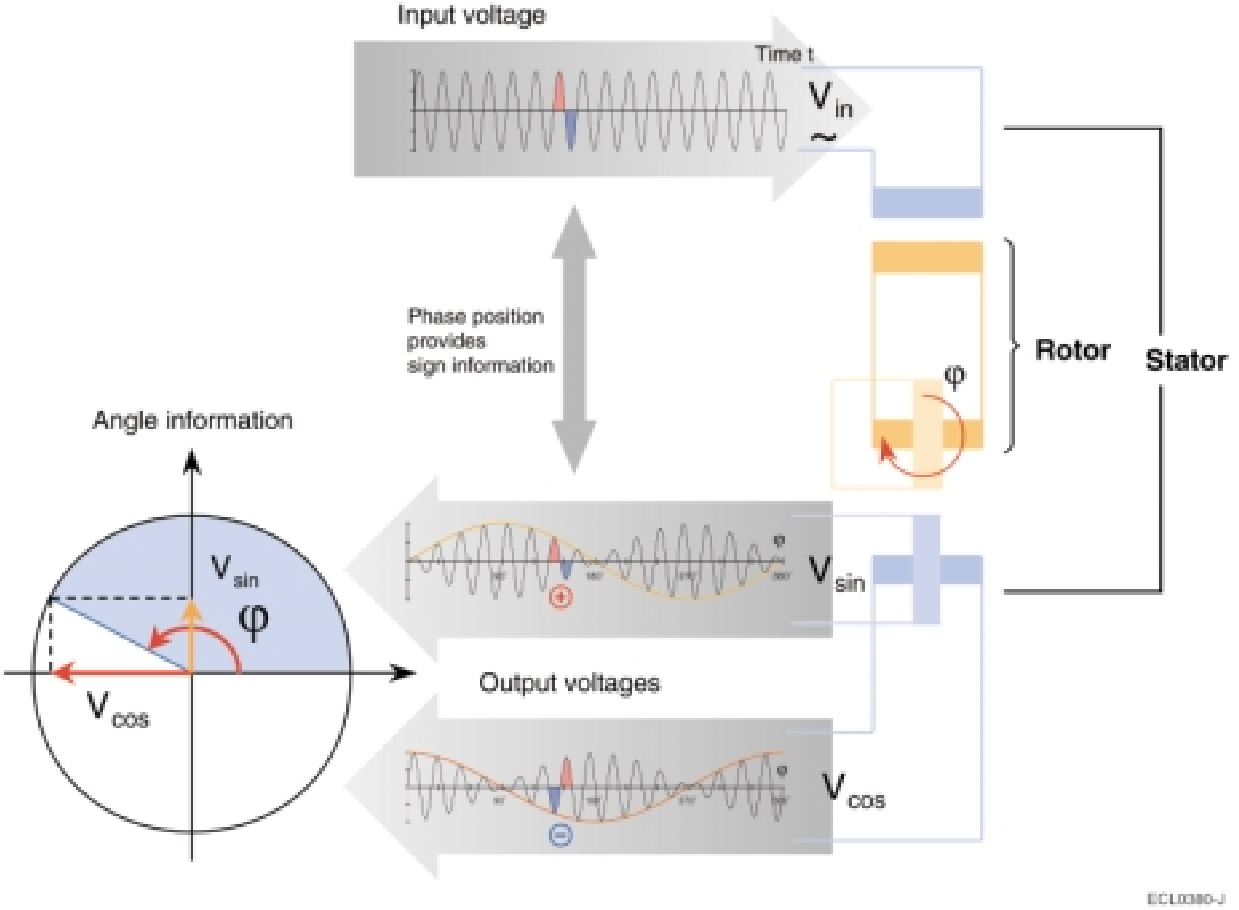
Negative values are realized by reversing the direction of the winding. The stator coils consist of two similar windings that are fitted in a relative position to each other rotated by 90°.

If the rotor winding is energized, a sinusoidal magnetic flux is created that induces voltages in the stator coils as a function of the relative angular position of the rotor and stator. The amplitudes of the two voltages correspond to the sine or cosine. Thus, using a suitable evaluation circuit, it is possible to obtain the absolute angle data.

The term used for the basic version is a resolver with one pair of poles (1-speed-resolver).

The number of pairs of poles indicates how often the sine distribution of the rotor and stator windings is repeated during one revolution. The higher the number of pairs of poles, the higher the mechanical precision of the resolver. The location deviation of the radial offset increases. With multiple pairs of poles, the absolute angle data are lost, but a higher resolution is possible after digital conversion of the resolver-signals.

Operational diagram



General Terms

Pairs of poles p (speed)
The number of electrical sine and cosine cycles per mechanical revolution.

Residual voltage $V_{residual}$
The residual voltage is the actual value of the voltage remaining when $V_{S1\text{-}S3}$ or $V_{S2\text{-}S4}$ takes on the nominal value of zero.

$V_{residual} < 0.7\ \%$ of $r_T \cdot V_{R1\text{-}R2}$

Angle error spread $\Delta\varphi$
The angle error spread is the deviation (unit: arcmin = ′) of the angle represented by the electrical signals from the corresponding actual mechanical angle.

$\Delta\varphi = \varphi_{el} - \varphi_{mech} \cdot p$ with p = pairs of poles

Applicable definition: the angle error spread lies within ± n arc minutes in any angular position of the specified band.

DC resistance values
The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K.

Phase shift ψ
The phase shift ψ is the lag between the input signal and output signal.

Transformation ratio r_T
The transformation ratio r_T is the ratio between the input voltage and the maximum output voltage.

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

Impedance values Z_{RO}; Z_{RS}; Z_{SO}; Z_{SS}
The impedance values are the ac resistance values and depend on the frequency. Especially Z_{SO} is the value relevant for the output capability of the resolver, while Z_{RS} is decisive for the load on the energizing signal source.

Overview of Standard Types

Size	Pairs of poles (speed)	Housing material	Angular error range	± 4′	± 6′	± 7′	± 8′	± 10′	± 15′	± 20′	Trans-formation ratio	Notes
			Ordering number	**..33**	**..10**	**..02**	**..09**	**..01**	**..22**	**..14**		
15	1	CrNi-steel	**V23401-D1001-B1..**			X		X	X	X	0.5	
	3	CrNi-steel	**V23401-D1008-B1..**			X		X	X	X	0.5	3-speed
	1	CrNi-steel	**V23401-D1009-B1..**			X		X	X	X	0.5	with low output impedance
	1	CrMo-steel	**V23401-S1001-B1..**		X		X	X	X		0.5	
21	3	Aluminum CrNi-steel	**V23401-T1002-B1..** **V23401-H1002-B1..**			X		X	X	X	0.5	3-speed
	1	Aluminum CrNi-steel	**V23401-T1005-B1..** **V23401-H1005-B1..**			X		X	X	X	0.5	
	1	Aluminum CrNi-steel	**V23401-T1009-B1..** **V23401-H1009-B1..**			X		X	X	X	0.5	with low output impedance
	1	Aluminum CrNi-steel	**V23401-T2001-B2..** **V23401-H2001-B2..**			X		X	X	X	0.5	
	1	Aluminum CrNi-steel	**V23401-T2009-B2..** **V23401-H2009-B2..**			X		X	X	X	0.5	with low output impedance
	3	Aluminum CrNi-steel	**V23401-T2010-B2..** **V23401-H2010-B2..**			X		X	X	X	0.46	3-speed
	4	Aluminum CrNi-steel	**V23401-T2014-B2..** **V23401-H2014-B2..**			X		X	X	X	0.46	4-speed
	2	Aluminum CrNi-steel	**V23401-T2015-B2..** **V23401-H2015-B2..**			X		X	X	X	0.5	2-speed
	1	CrMo-steel	**V23401-U1016-B1..**	X	X		X	X			0.5	
	1	CrMo-steel	**V23401-U2017-B2..**	X		X		X			0.5	
	3	CrMo-steel	**V23401-U2020-B2..**		X		X	X			0.46	3-speed

Hollow Shaft Resolver Size 15

V23401-D1…
V23401-S1…

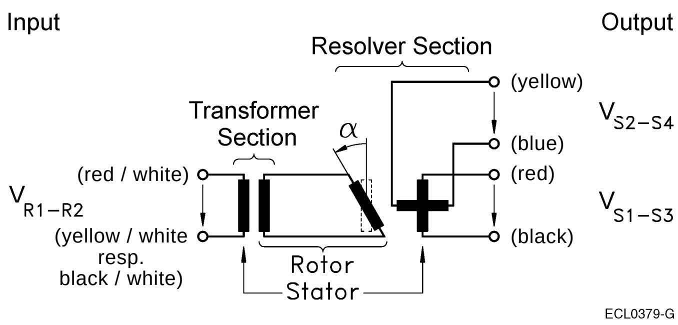
Transfer function

Function

$V_{S1\text{-}S3} = +r_T \cdot V_{R1\text{-}R2} \cdot \cos(p \cdot \alpha)$
$V_{S2\text{-}S4} = +r_T \cdot V_{R1\text{-}R2} \cdot \sin(p \cdot \alpha)$

p = pairs of poles

This function applies to the clockwise rotation of the rotor when looking at the (grooveless) transformer component from the top.



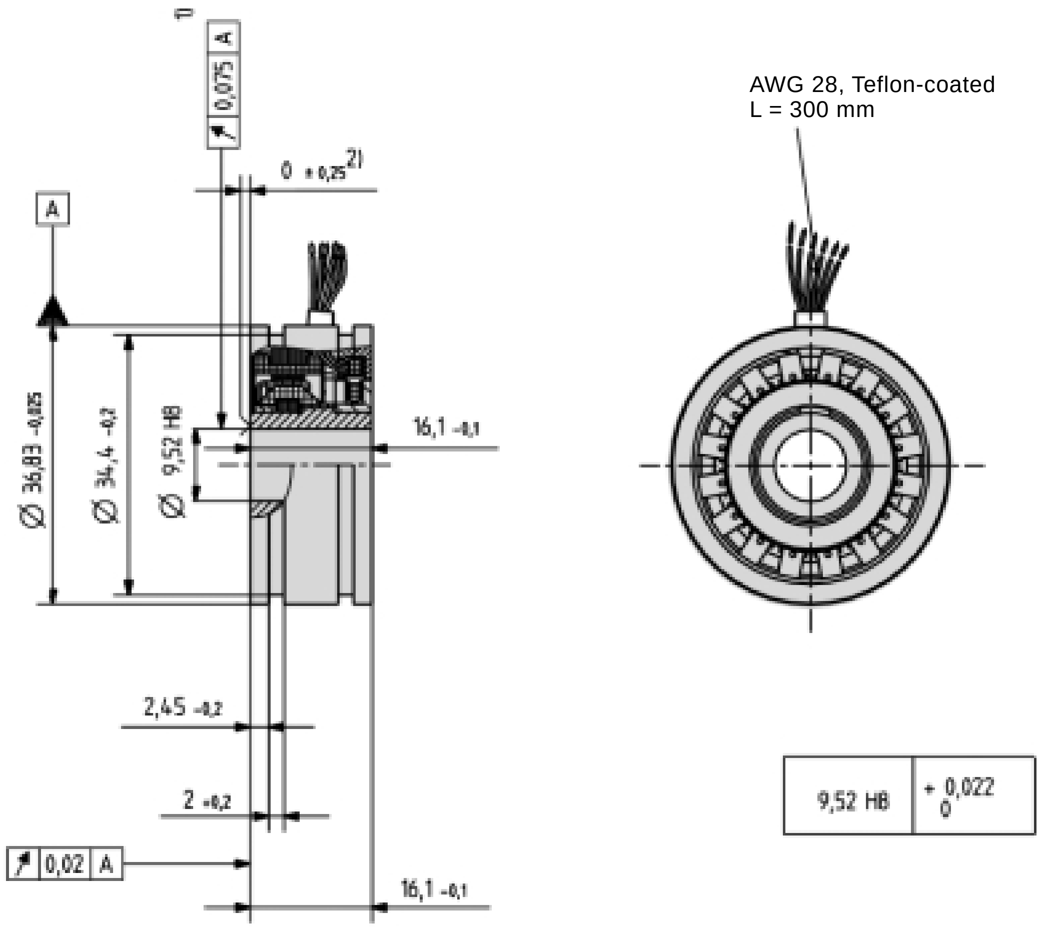
Electrical and thermal limits

High-voltage test Windings to housing Windings to each other	 250 V_{AC}, 50 Hz 250 V_{AC}, 50 Hz
Insulation resistance Windings to housing and windings to each other	$R_{insulation}$ > 50 MΩ at 500 V_{DC}
Operating temperature range	–55 °C ... +150 °C

Mechanical data

Weight V23401-D... V23401-S...	 approx. 90 g approx. 90 g
Momentum of inertia of the rotor	approx. 20 g · cm^2
Maximum rational speed	20000 rpm
Maximum angular acceleration	150000 rad/s^2
Torsional strength of rotor components	0.25 Nm
Shock resistance (11 ms sine)	1000 m/s^2
Vibration fatigue limit (0 ... 2 kHz)	200 m/s^2
Permissible radial runout (see Dimensioned drawing: Note 1)	0.075 mm
Permissible axial offset (see Dimensioned drawing: Note 2)	± 0.25 mm

Dimensioned drawing



1) Total runout when installed
2) Axial offset

Housing	CrNi-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 20′	V23401-D1001-B114
± 15′	V23401-D1001-B122
± 10′	V23401-D1001-B101
± 7′	V23401-D1001-B102
Residual voltage $V_{residual}$	25 mV at $V_{R1\text{-}R2}$ = 7 V

Electrical data at 22 °C.

Transfer function

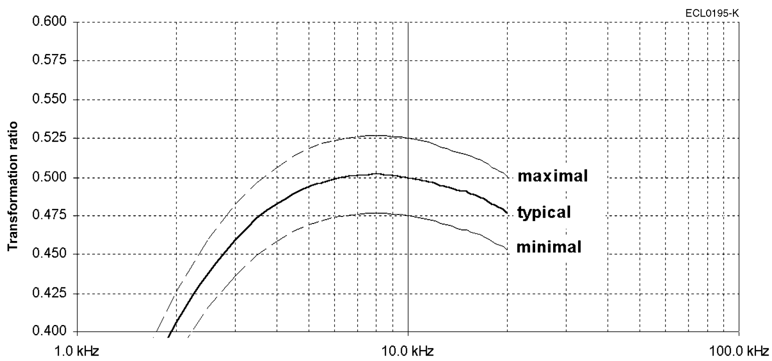
Pairs of poles p: p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\,max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\,max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 4 ... 20 kHz
= 0.5 ± 5 % at 5 kHz



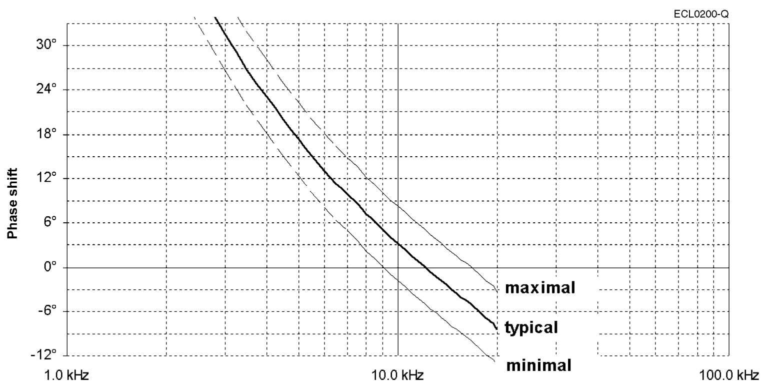
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 15

Resistance, impedance and operating parameters

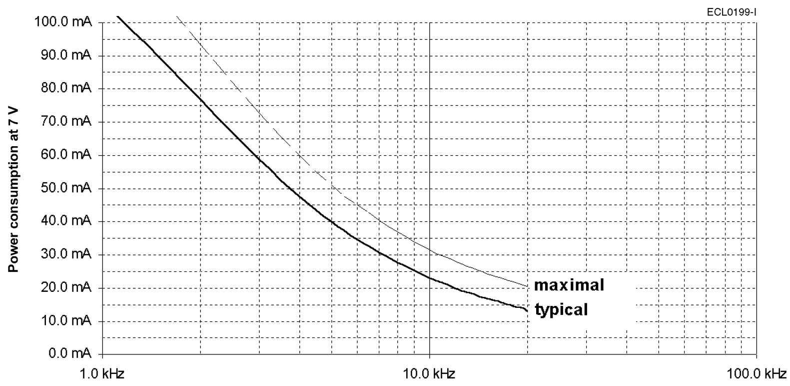
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤0.3 W is not critical.
Frequency f, typical	4 kHz ... 20 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 7\ V$

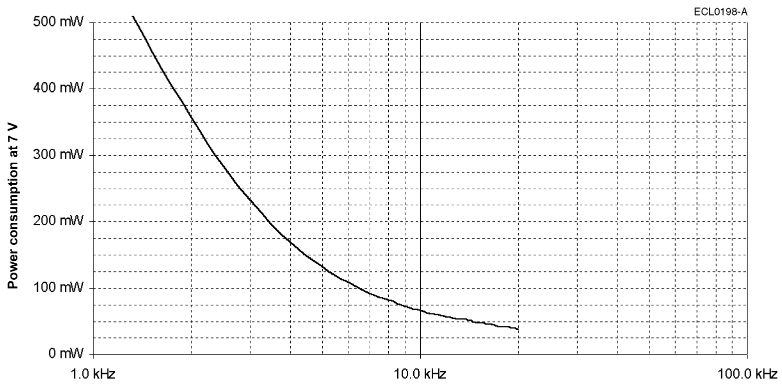


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 7\ V)^2$



Resistance, impedance and operating parameters (continued)

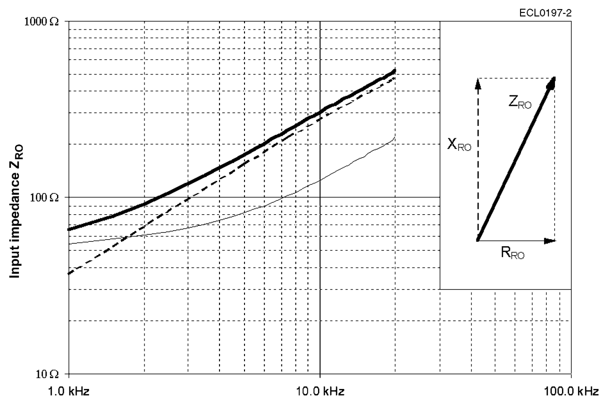
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

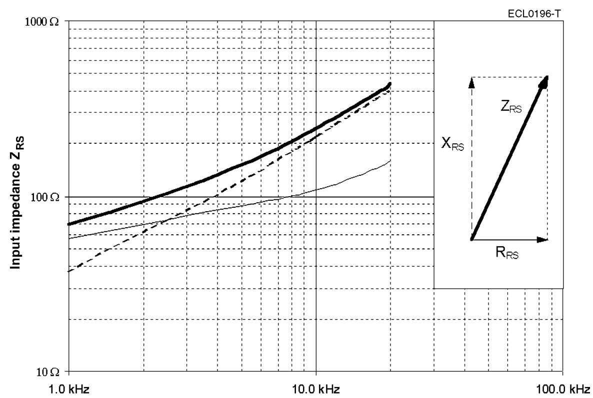
$R_{R1\text{-}R2}$ = 46 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 63 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

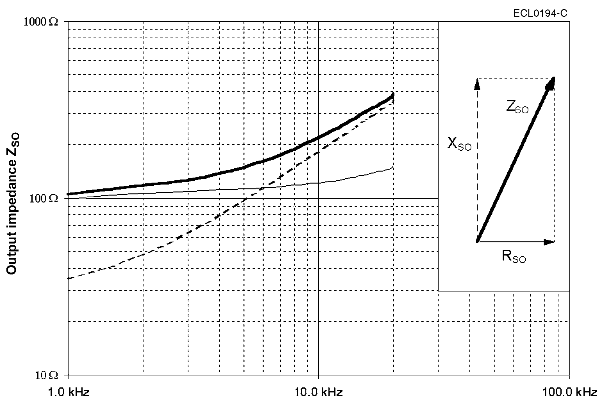


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

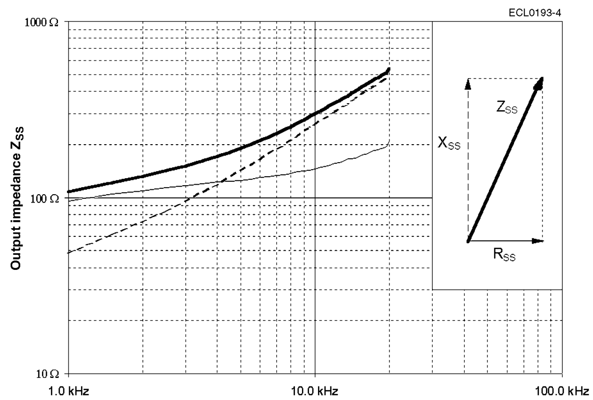


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 4.4 mH
L_{SS} = 4.1 mH

Housing	CrNi-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 20′	V23401-D1008-B114
± 15′	V23401-D1008-B122
± 10′	V23401-D1008-B101
± 7′	V23401-D1008-B102
Residual voltage $V_{residual}$	14 mV at $V_{R1\text{-}R2}$ = 4 V

Electrical data at 22 °C.

Transfer function

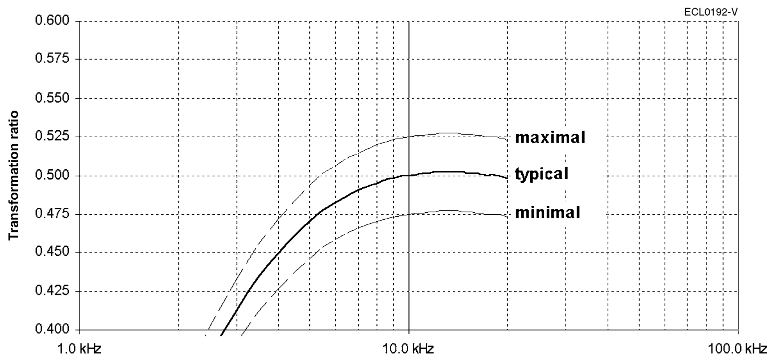
Pairs of poles p: p = 3

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 5 ... 20 kHz
= 0.5 ± 5 % at 10 kHz



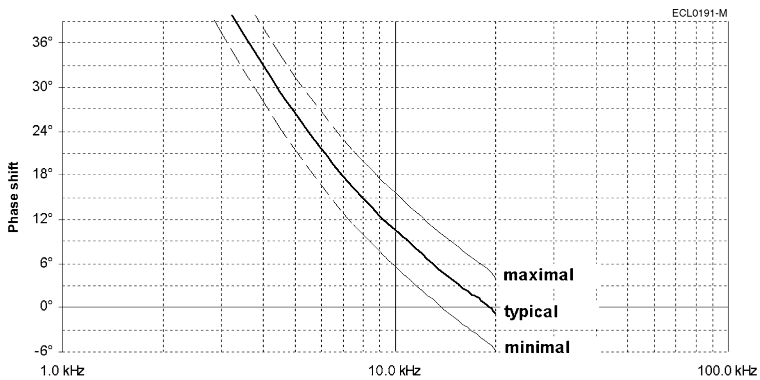
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for –90° < α < +90°

Tolerance: ± 5°



Size 15

Resistance, impedance and operating parameters

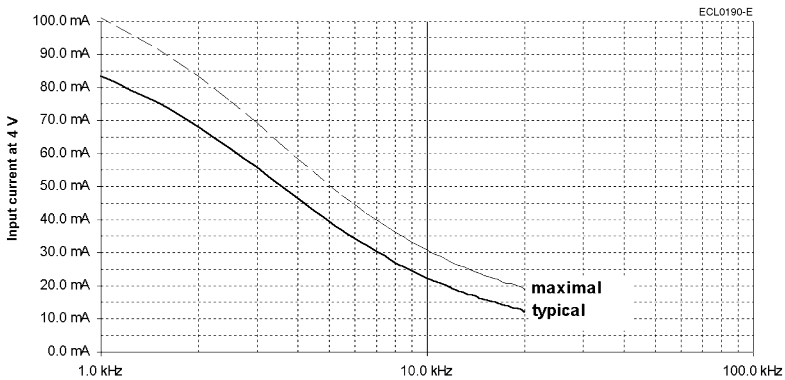
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 8 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of $P \leq 0.3$ W is not critical.
Frequency f, typical	5 kHz ... 20 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 4 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 4\ V$

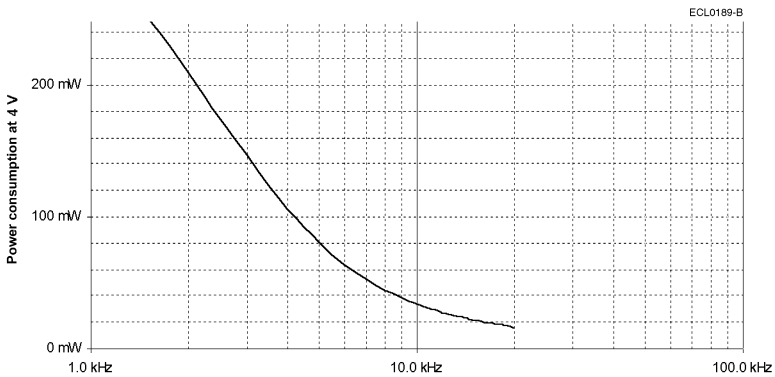


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 4 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 4\ V)^2$



Size 15

Resistance, impedance and operating parameters (continued)

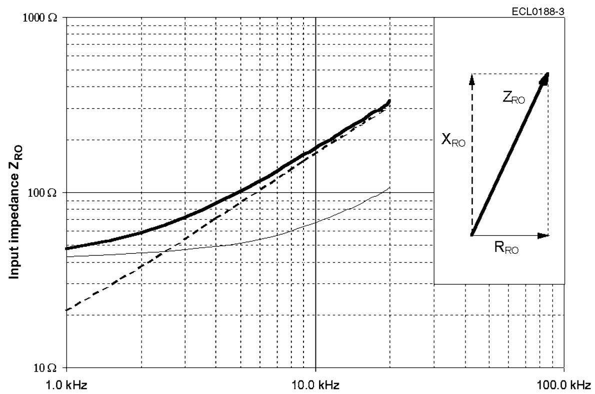
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

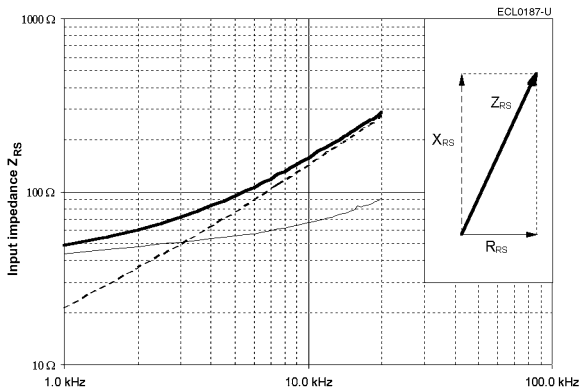
$R_{R1\text{-}R2}$ = 33 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 70 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

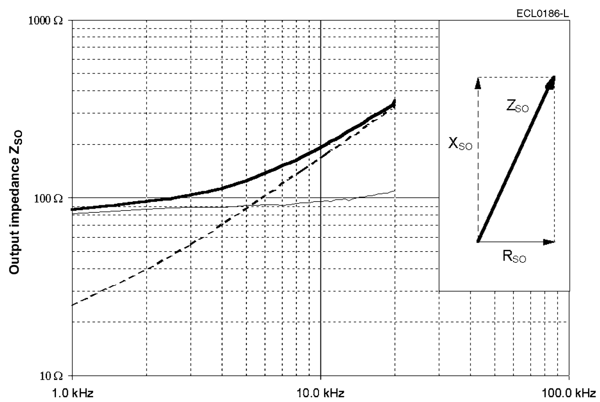


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

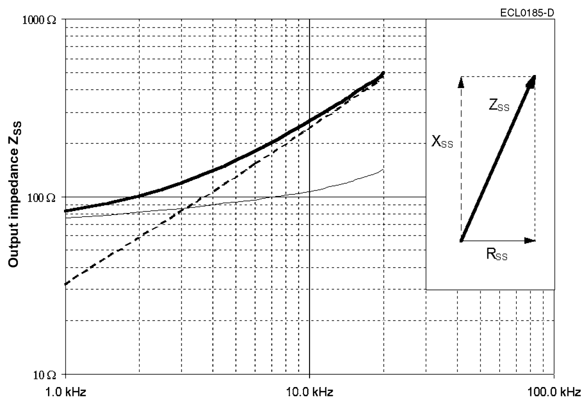


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 2.6 mH
L_{SS} = 3.9 mH

Housing	CrNi-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 20′	V23401-D1009-B114
± 15′	V23401-D1009-B122
± 10′	V23401-D1009-B101
± 7′	V23401-D1009-B102
Residual voltage $V_{residual}$	14 mV at $V_{R1\text{-}R2}$ = 4 V

Electrical data at 22 °C.

Transfer function

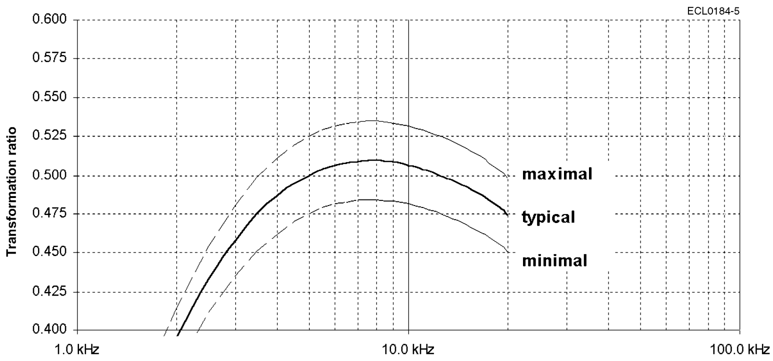
Pairs of poles p: p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 4 ... 20 kHz
= 0.5 ± 5 % at 5 kHz



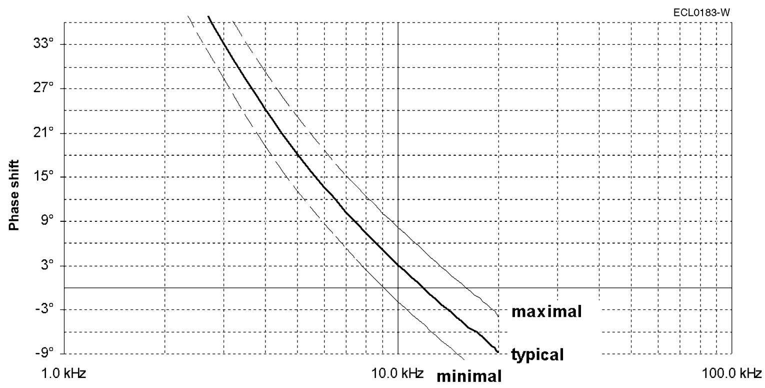
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 15

Resistance, impedance and operating parameters

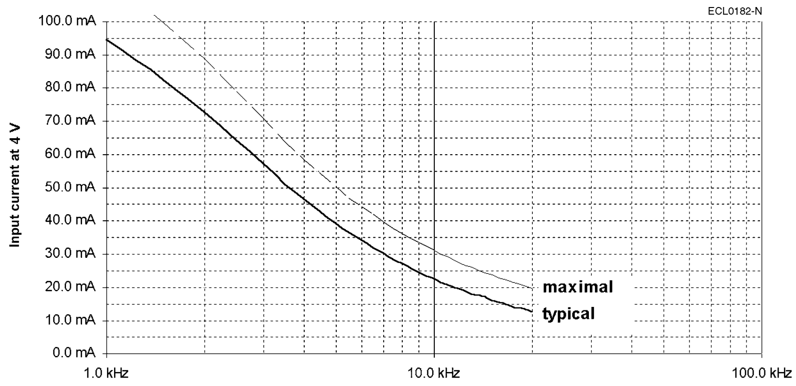
Input voltage V_{R1-R2}, typical	2 V_{rms} ... 8 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤0.3 W is not critical.
Frequency f, typical	4 kHz ... 20 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 4\ V$

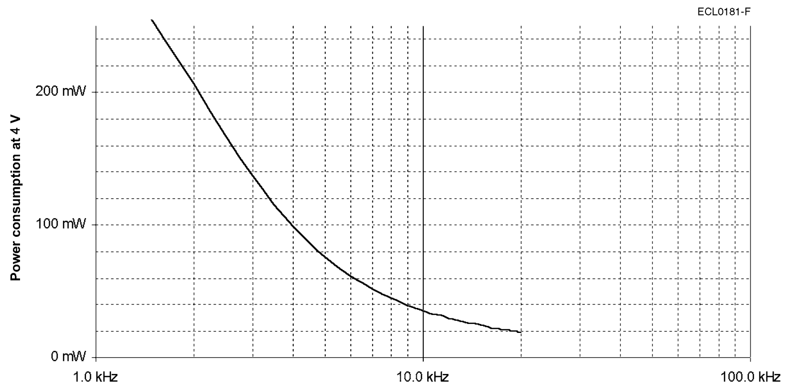


Power consumption P

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 4\ V)^2$



Resistance, impedance and operating parameters (continued)

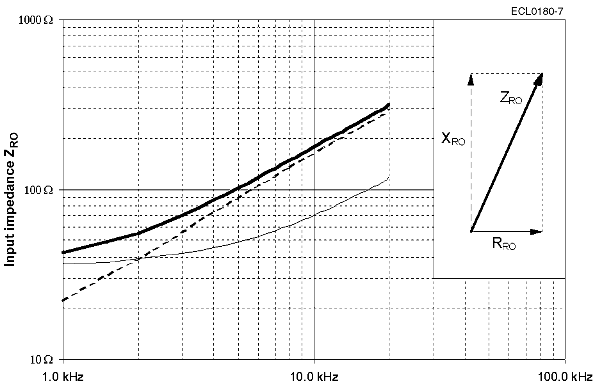
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

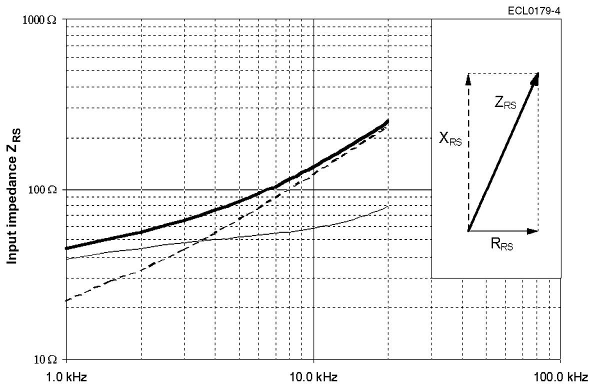
$R_{R1\text{-}R2}$ = 31 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 28 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

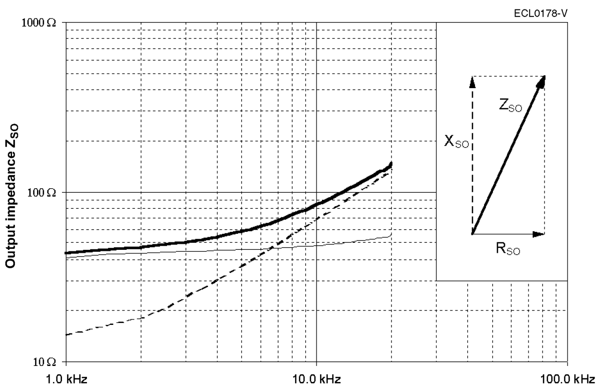


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

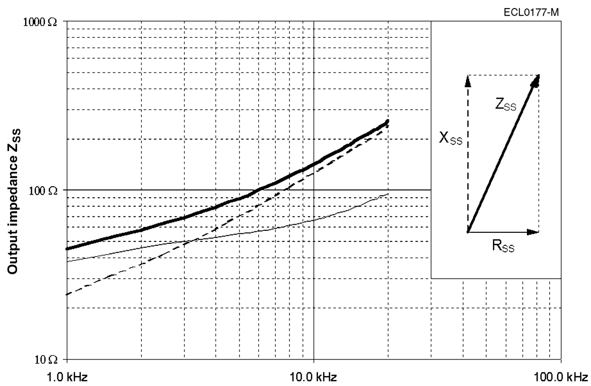


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 2.6 mH
L_{SS} = 2.0 mH

Housing	CrMo-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 15′	V23401-S1001-B122
± 10′	V23401-S1001-B101
± 8′	V23401-S1001-B109
± 6′	V23401-S1001-B110
Residual voltage $V_{residual}$	25 mV at $V_{R1\text{-}R2}$ = 7 V

Electrical data at 22 °C.

Transfer function

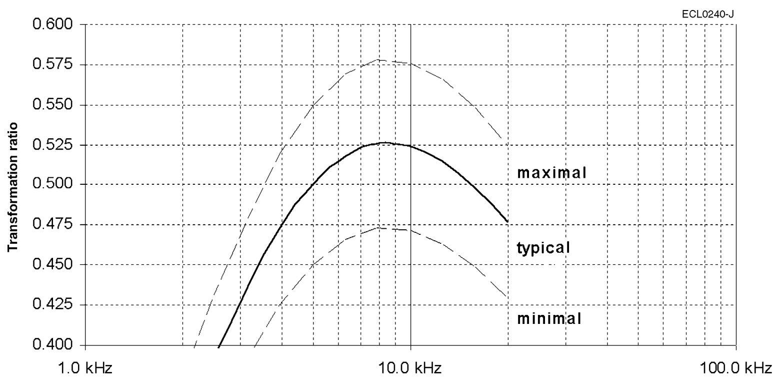
Pairs of poles p	p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 4 ... 20 kHz
= 0.5 ± 5 % at 5 kHz



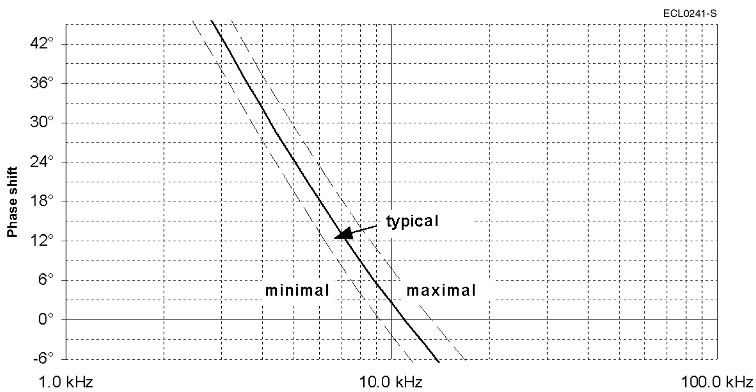
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 15

Resistance, impedance and operating parameters

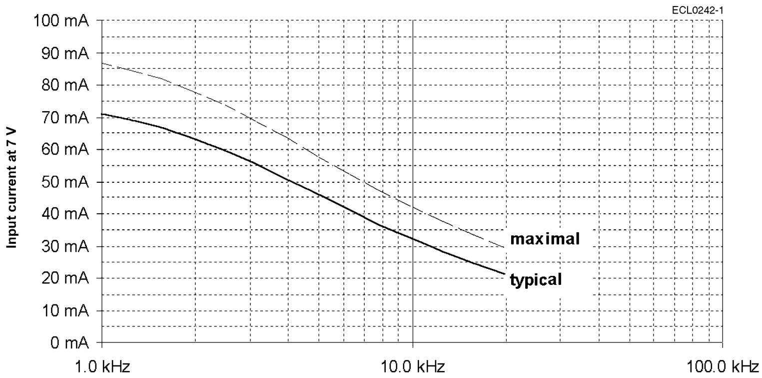
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.3 W is not critical.
Frequency f, typical	4 kHz ... 20 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 7\ V$

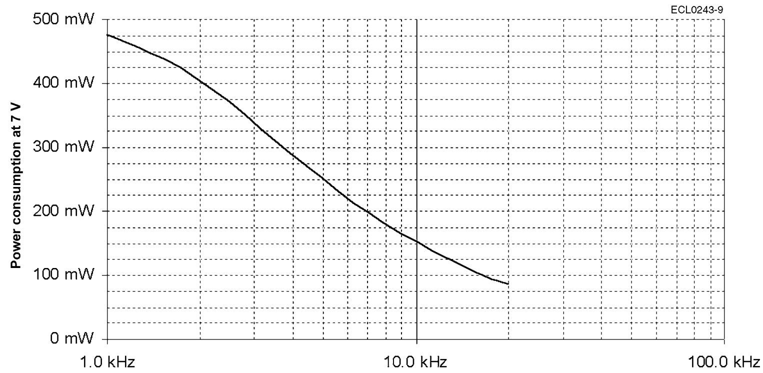


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 7\ V)^2$



Size 15

Resistance, impedance and operating parameters (continued)

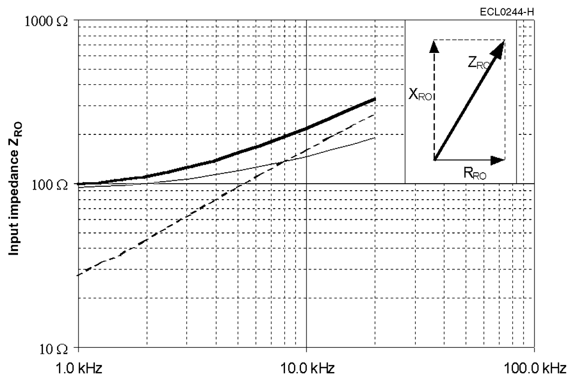
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

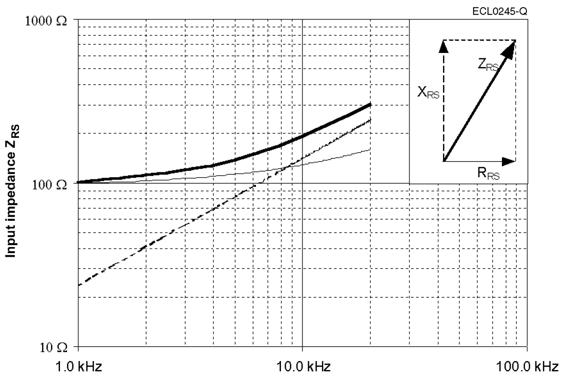
R_{R1-R2} = 82 Ω
R_{S1-S3} = R_{S2-S4} = 68 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

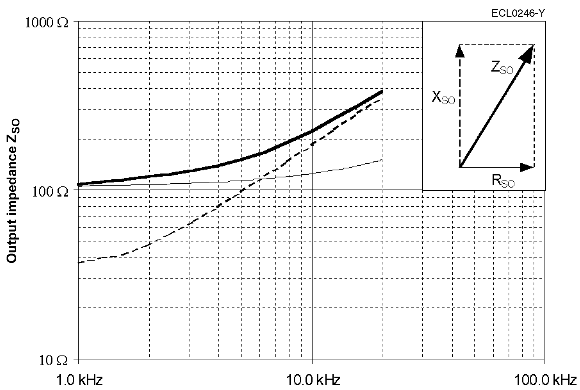


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

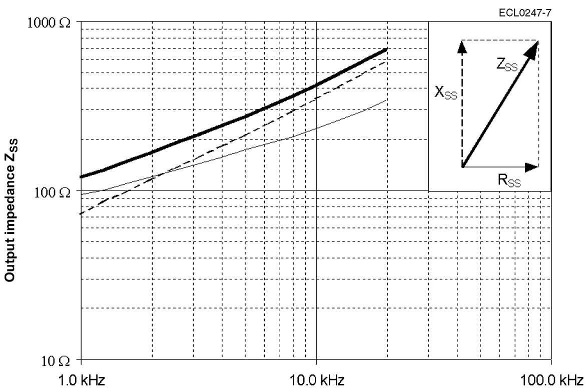


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 5 kHz

L_{RO} = 2.5 mH
L_{SS} = 5.8 mH

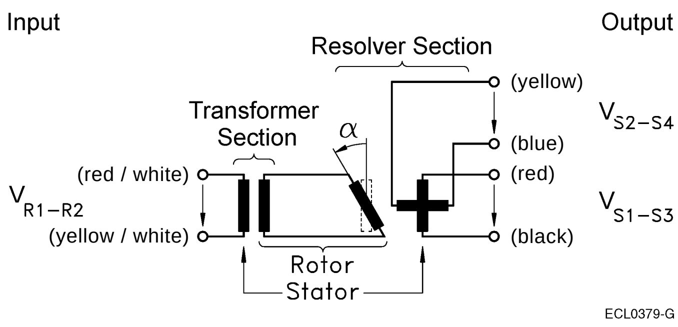
Transfer function

Function

$V_{S1\text{-}S3} = +r_T \cdot V_{R1\text{-}R2} \cdot \cos(p \cdot \alpha)$
$V_{S2\text{-}S4} = +r_T \cdot V_{R1\text{-}R2} \cdot \sin(p \cdot \alpha)$

p = pairs of poles

This function applies to the clockwise rotation of the rotor when looking at the (grooveless) transformer component from the top.



Electrical and thermal limits

High-voltage test Windings to housing Windings to each other	 500 V_{AC}, 50 Hz 250 V_{AC}, 50 Hz
Insulation resistance Windings to housing and windings to each other	$R_{insulation}$ > 50 MΩ at 500 V_{DC}
Operating temperature range	–55 °C ... +150 °C

Mechanical data

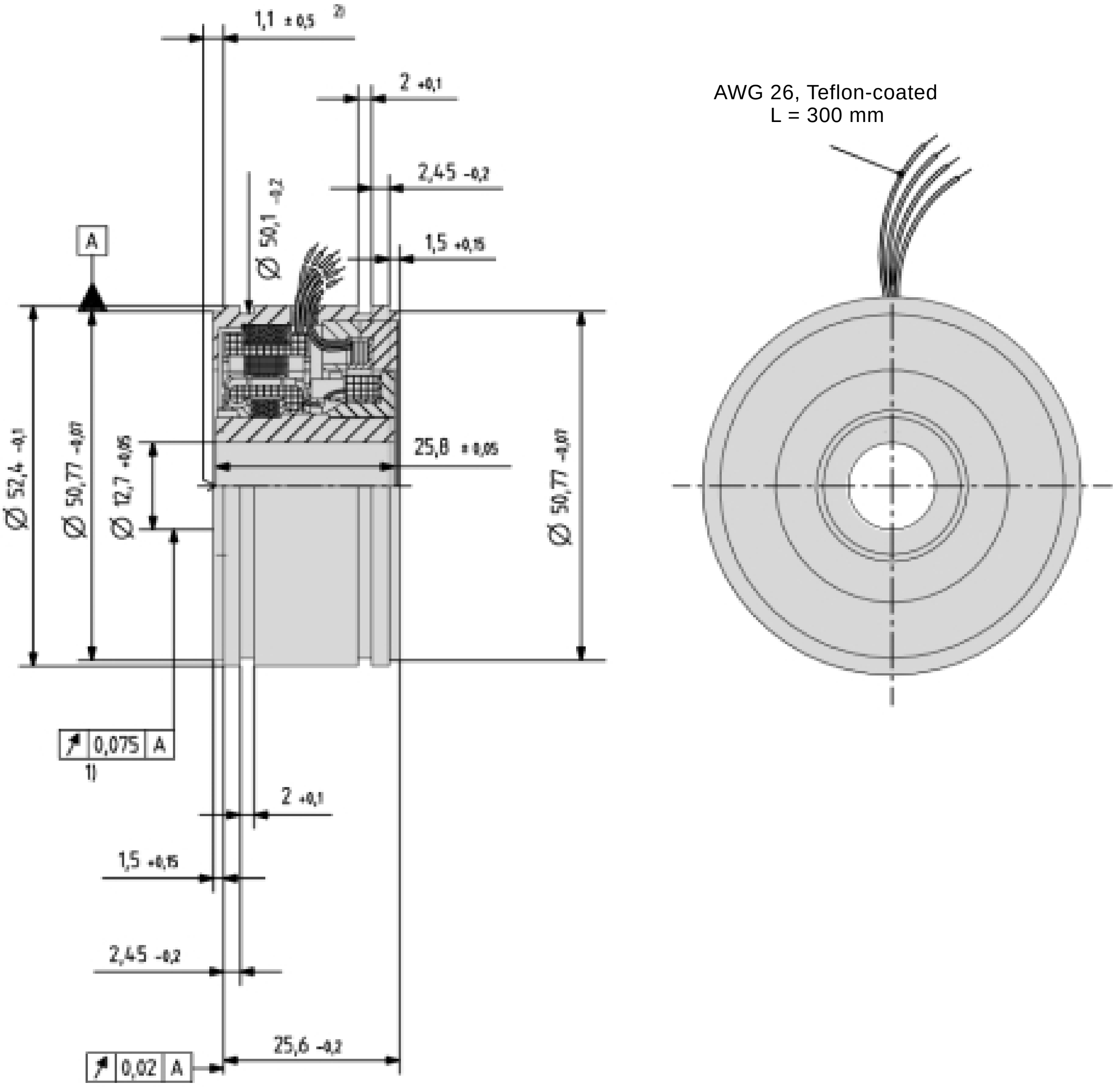
Weight V23401-T10... V23401-H10... V23401-U10… V23401-T20… V23401-H20… V23401-U20…	 approx. 240 g approx. 290 g approx. 290 g approx. 210 g approx. 260 g approx. 260 g
Momentum of inertia of the rotor	approx. 200 g · cm^2
Maximum rational speed	20000 rpm
Maximum angular acceleration	64000 rad/s^2
Torsional strength of rotor components	1 Nm
Shock resistance (11 ms sine)	1000 m/s^2
Vibration fatigue limit (0 ... 2 kHz)	200 m/s^2
Permissible radial runout (see Dimensioned drawing: Note 1)	0.075 mm
Permissible axial offset (see Dimensioned drawing: Note 2)	± 0.5 mm

Hollow Shaft Resolver Size 21

V23401-T1…
V23401-H1…
V23401-U1…

Dimensioned drawing

V23401-T1... / H1... / U1...



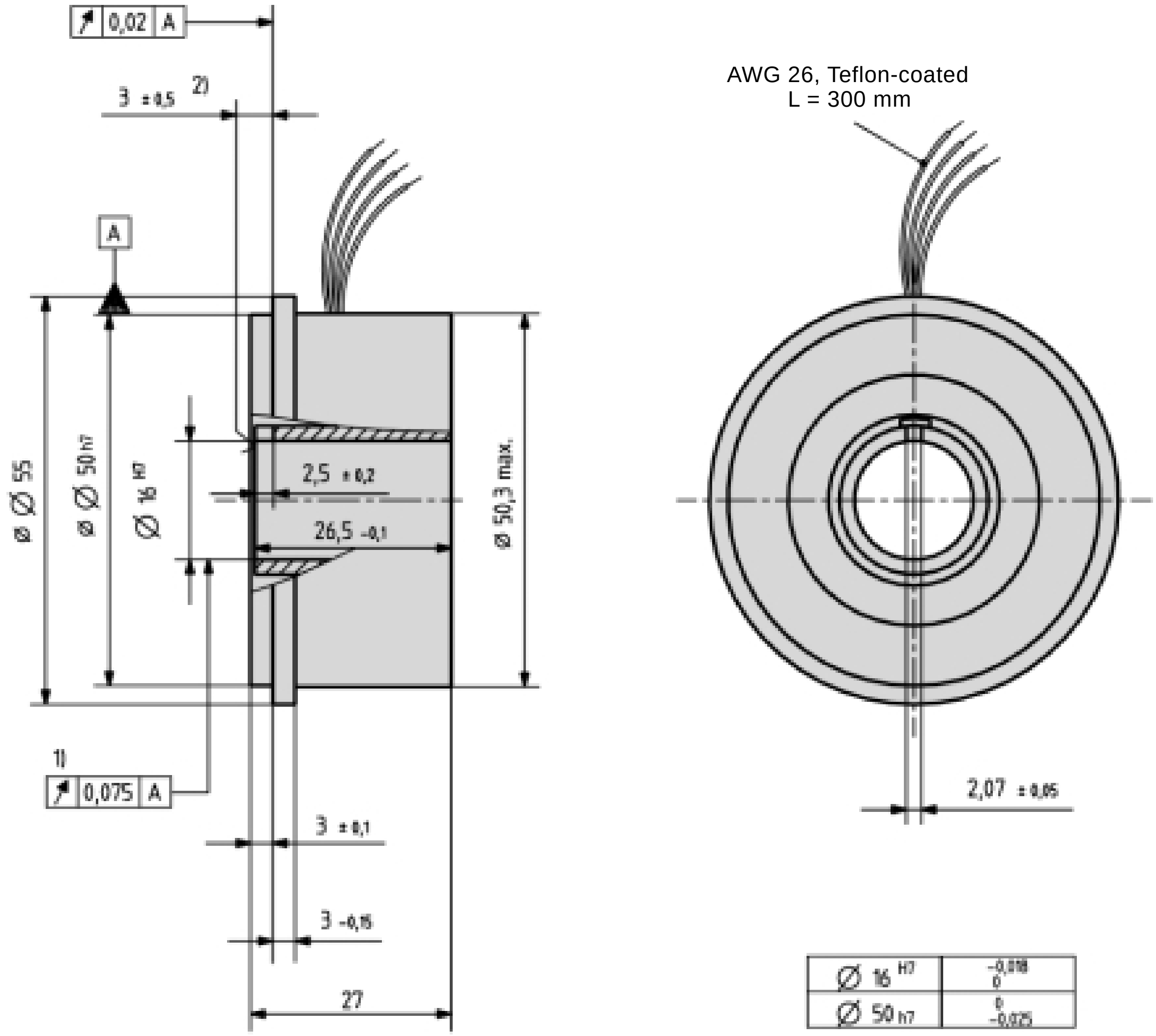
1) Total runout when installed
2) Axial offset

Hollow Shaft Resolver Size 21

V23401-T2…
V23401-H2…
V23401-U2…

Dimensioned drawing

V23401-T2... / H2... / U2...



Ø 16 H7	-0,018 0
Ø 50 h7	0 -0,025

1) Total runout when installed
2) Axial offset

Size 21

Housing	Aluminum	V23401-T 1002-B1..
	CrNi-steel	V23401-H1002-B1..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T1002-B114	V23401-H1002-B114
± 15′	V23401-T1002-B122	V23401-H1002-B122
± 10′	V23401-T1002-B101	V23401-H1002-B101
± 7′	V23401-T1002-B102	V23401-H1002-B102
Residual voltage $V_{residual}$	25 mV at $V_{R1\text{-}R2}$ = 7 V	

Electrical data at 22 °C.

Transfer function

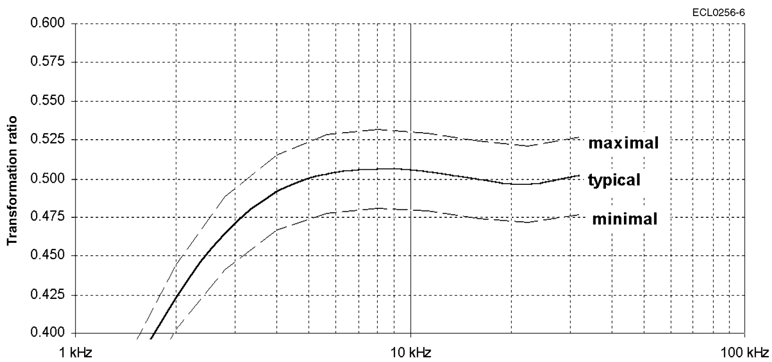
Pairs of poles p: p = 3

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 3 ... 20 kHz
= 0.5 ± 5 % at 5 kHz



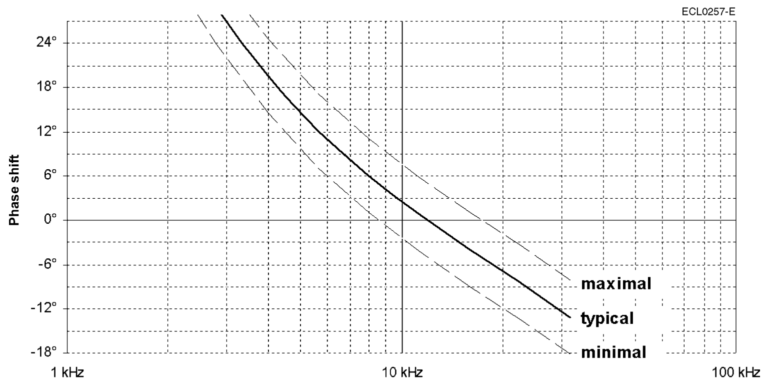
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

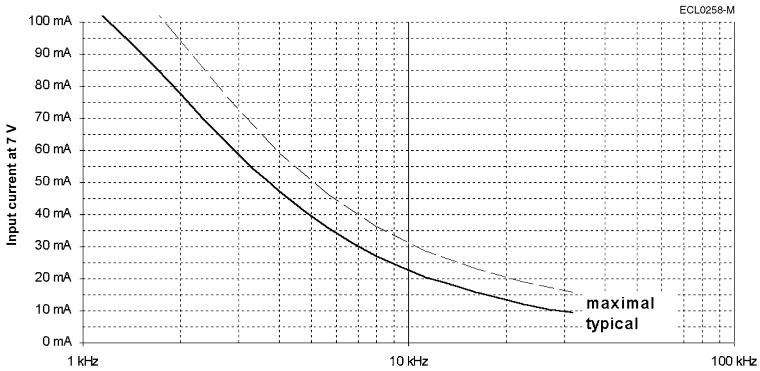
Input voltage V_{R1-R2}, typical	4 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	3 kHz ... 15 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 7 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 7\ V$

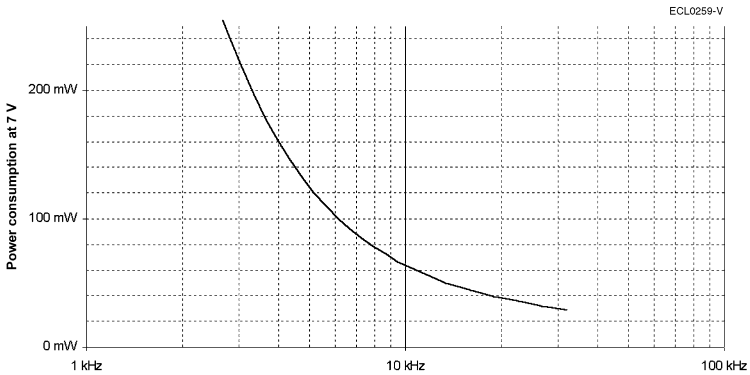


Power consumption P

The adjacent figure applies to V_{R1-R2} = 7 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 7\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

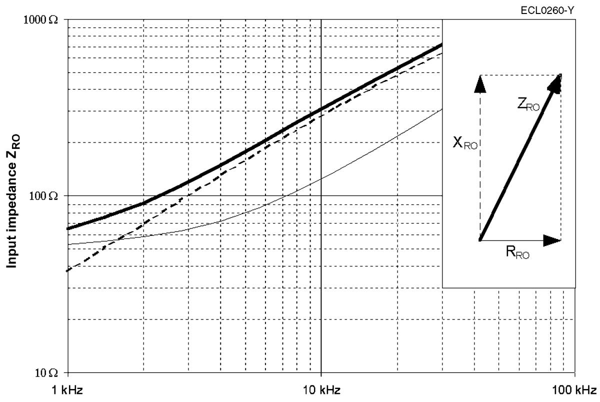
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

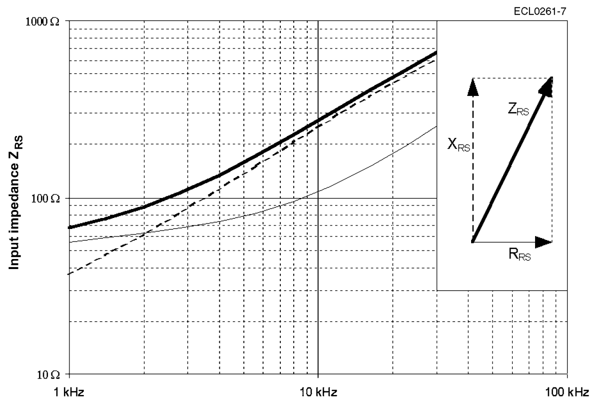
$R_{R1\text{-}R2}$ = 39 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 94 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

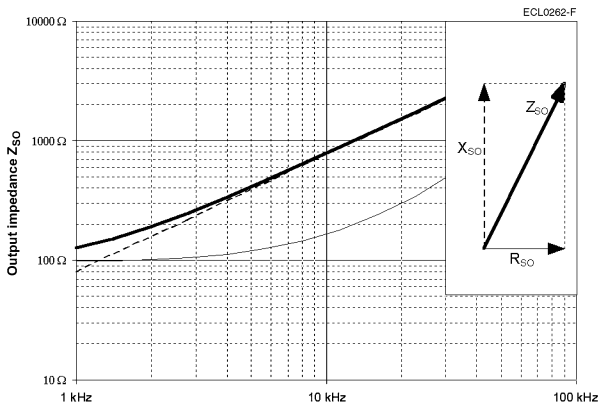


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

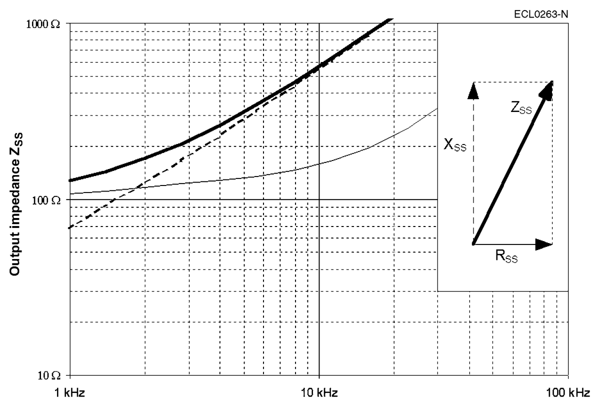


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 8 kHz

L_{RO} = 4.7 mH
L_{SS} = 8.8 mH

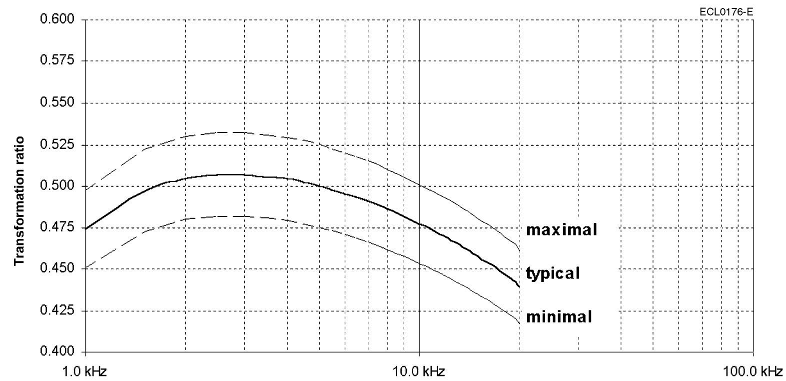
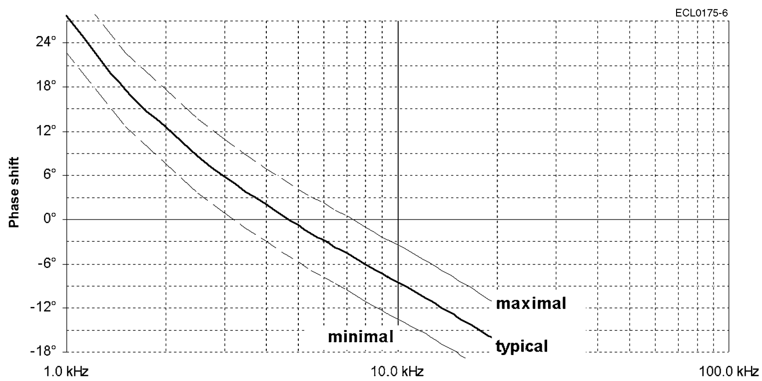
Housing	Aluminum V23401-T 1005-B1.. CrNi-steel V23401-H1005-B1..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T1005-B114	V23401-H1005-B114
± 15′	V23401-T1005-B122	V23401-H1005-B122
± 10′	V23401-T1005-B101	V23401-H1005-B101
± 7′	V23401-T1005-B102	V23401-H1005-B102
Residual voltage $V_{residual}$	25 mV at V_{R1-R2} = 7 V	

Electrical data at 22 °C.

Transfer function

Pairs of poles p	p = 1
Transformation ratio r_T $r_T = V_{S1-S3\,max} / V_{R1-R2}$ $= V_{S2-S4\,max} / V_{R1-R2}$ = 0.5 ± 10 % within 2 ... 10 kHz = 0.5 ± 5 % at 5 kHz	
Phase shift ψ $V_{R1-R2}(t) = V_{R1-R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$ $V_{S1-S3}(t) = V_{S1-S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$ for $-90° < \alpha < +90°$ Tolerance: ± 5°	

Size 21

Resistance, impedance and operating parameters

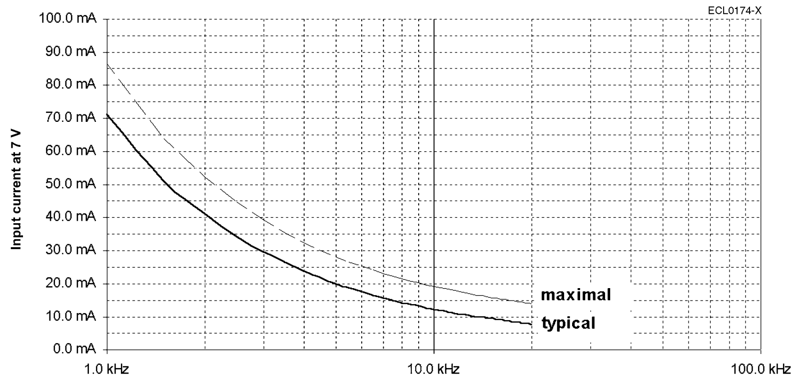
Input voltage $V_{R1\text{-}R2}$, typical	4 V_{rms} ... 12 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 7\ V$

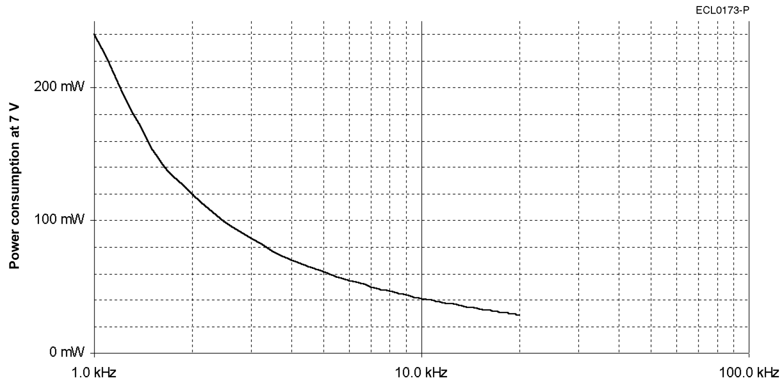


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 7 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 7\ V)^2$



Resistance, impedance and operating parameters (continued)

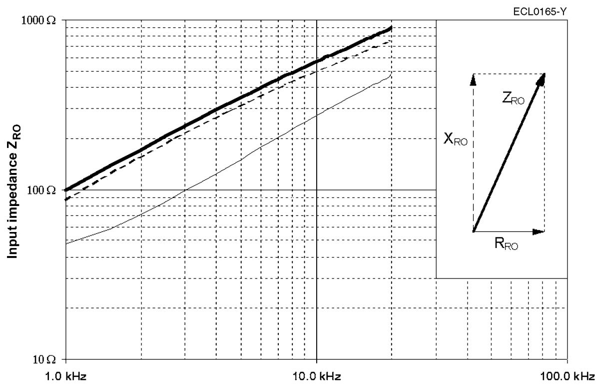
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

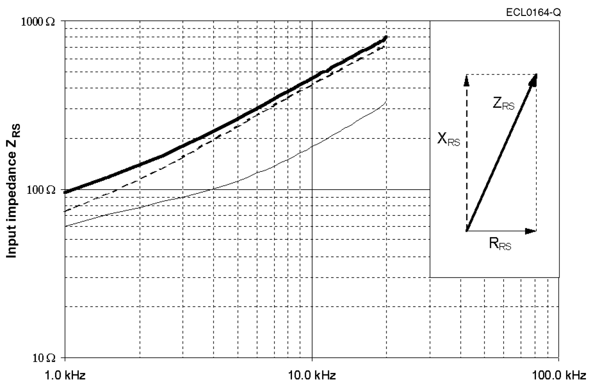
R_{R1-R2} = 24 Ω
R_{S1-S3} = R_{S2-S4} = 58 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

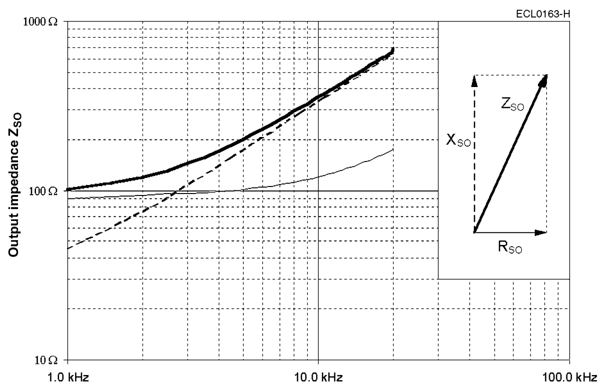


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

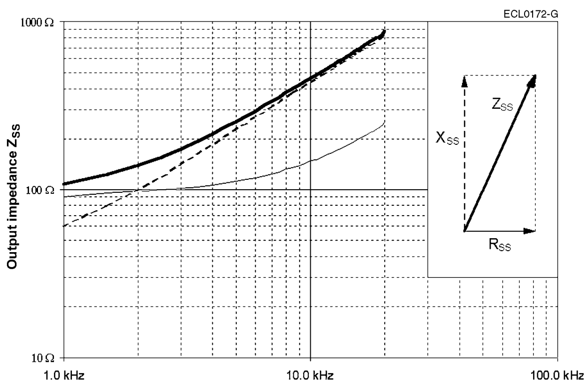


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 7.9 mH
L_{SS} = 6.9 mH

Size 21

Hollow Shaft Resolver Size 21

V23401-T 1009-B1..
V23401-H1009-B1..
with low output impedance

Housing	Aluminum	V23401-T 1009-B1..
	CrNi-steel	V23401-H1009-B1..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T1009-B114	V23401-H1009-B114
± 15′	V23401-T1009-B122	V23401-H1009-B122
± 10′	V23401-T1009-B101	V23401-H1009-B101
± 7′	V23401-T1009-B102	V23401-H1009-B102
Residual voltage $V_{residual}$	14 mV at V_{R1-R2} = 4 V	

Electrical data at 22 °C.

Transfer function

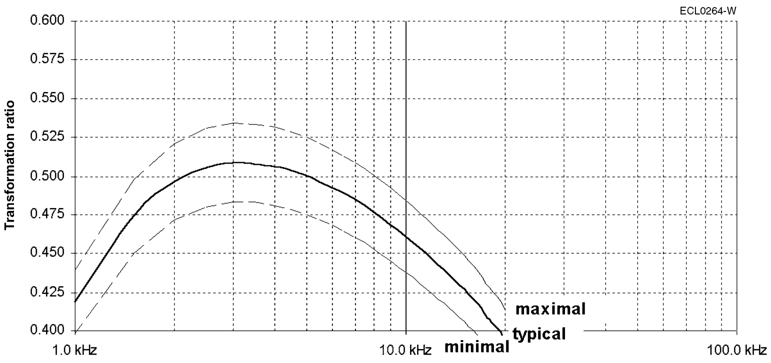
Pairs of poles p: p = 1

Transformation ratio r_T

$r_T = V_{S1-S3\ max} / V_{R1-R2}$

$= V_{S2-S4\ max} / V_{R1-R2}$

= 0.5 ± 10 % within 2 ... 8 kHz
= 0.5 ± 5 % at 5 kHz



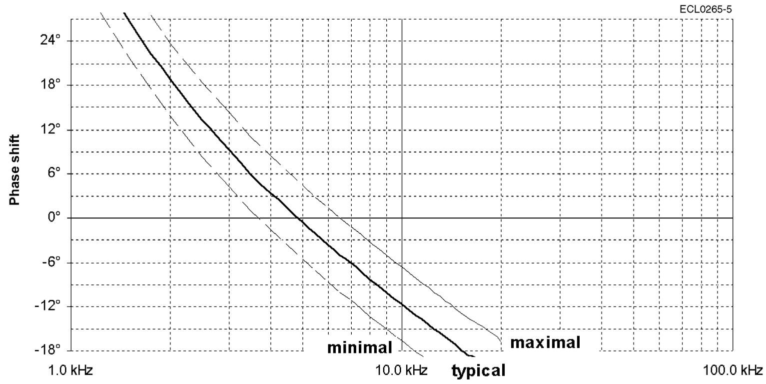
Phase shift ψ

$V_{R1-R2}(t) = V_{R1-R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1-S3}(t) = V_{S1-S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

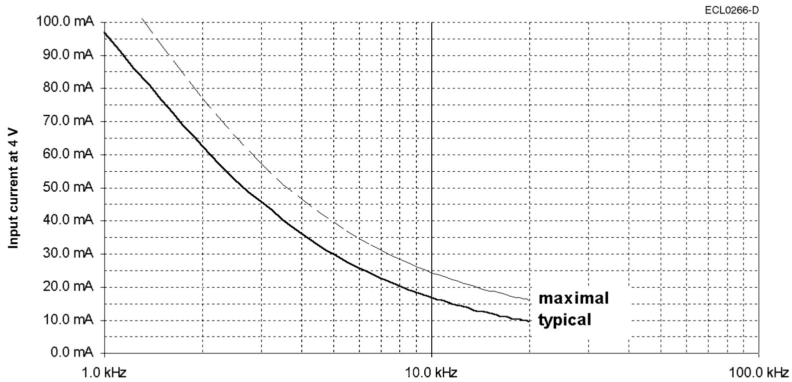
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 8 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 4 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 4\ V$

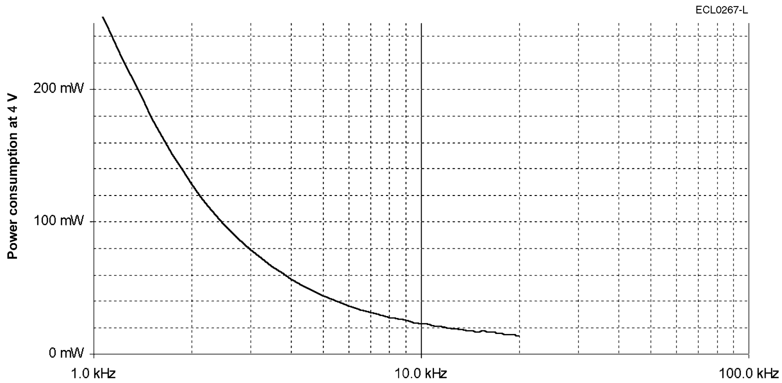


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 4 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 4\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

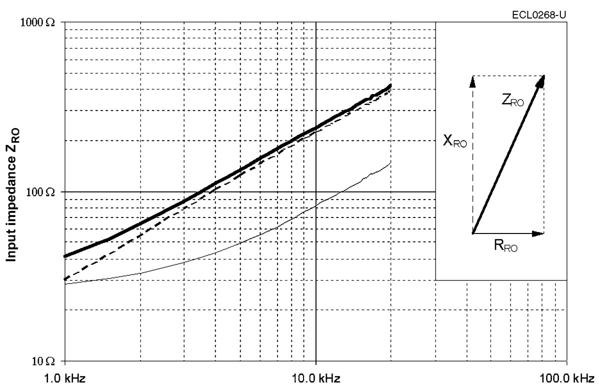
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

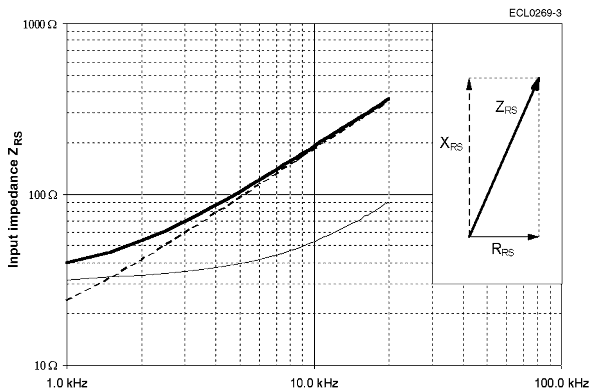
$R_{R1\text{-}R2}$ = 21 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 22 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

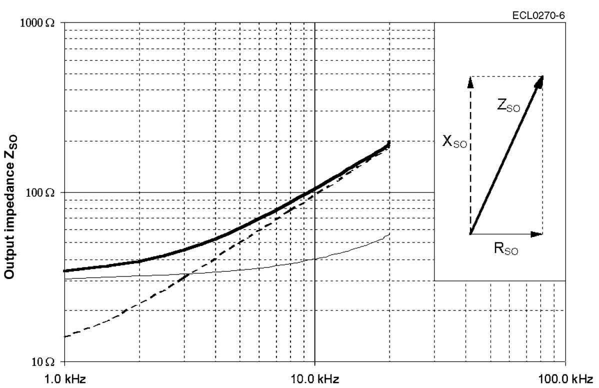


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

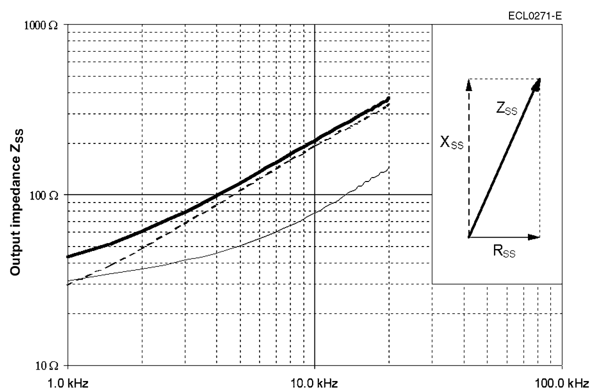


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 3.5 mH
L_{SS} = 3.1 mH

Housing	Aluminum	V23401-T 2001-B2..
	CrNi-steel	V23401-H2001-B2..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T2001-B214	V23401-H2001-B214
± 15′	V23401-T2001-B222	V23401-H2001-B222
± 10′	V23401-T2001-B201	V23401-H2001-B201
± 7′	V23401-T2001-B202	V23401-H2001-B202
Residual voltage $V_{residual}$	25 mV at $V_{R1\text{-}R2}$ = 7 V	

Electrical data at 22 °C.

Transfer function

Pairs of poles p

p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\,max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\,max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 2 ... 10 kHz
= 0.5 ± 5 % at 5 kHz

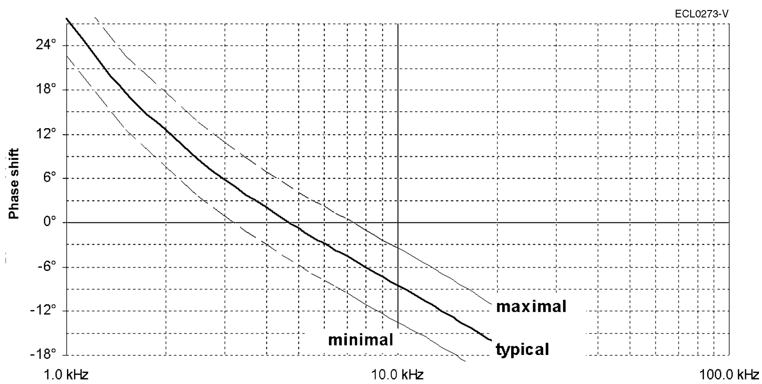
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

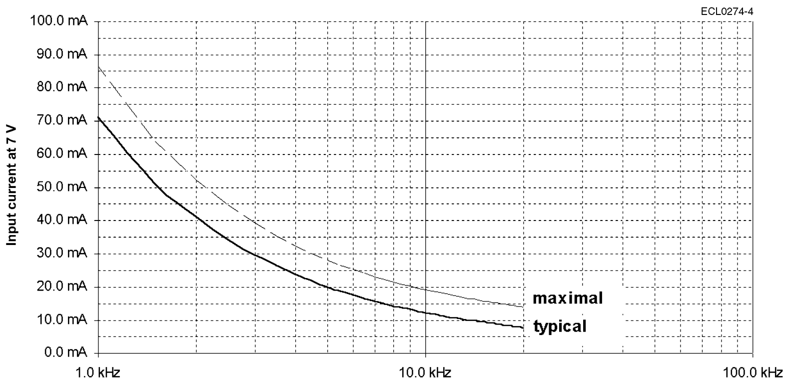
Input voltage V_{R1-R2}, typical	4 V_{rms} ... 12 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 7 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 7\ V$

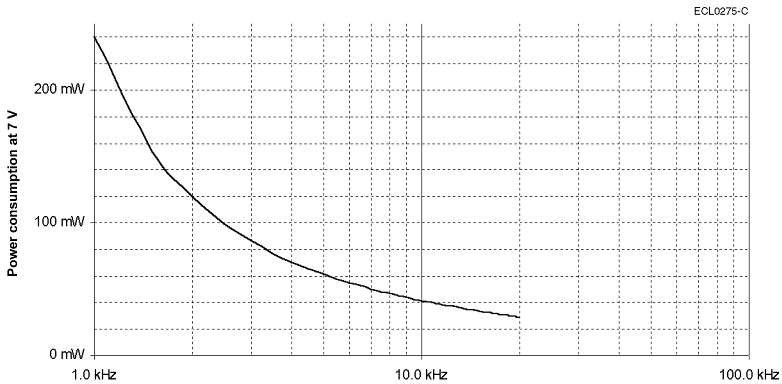


Power consumption P

The adjacent figure applies to V_{R1-R2} = 7 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 7\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

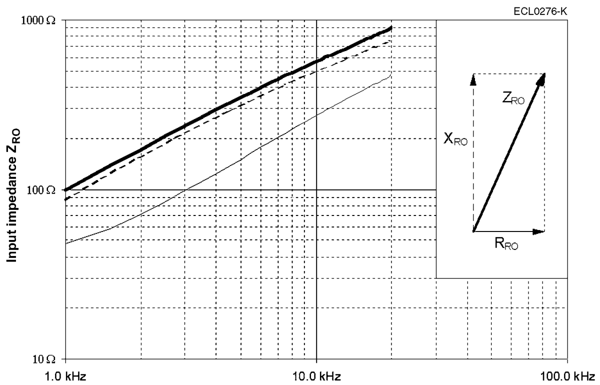
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

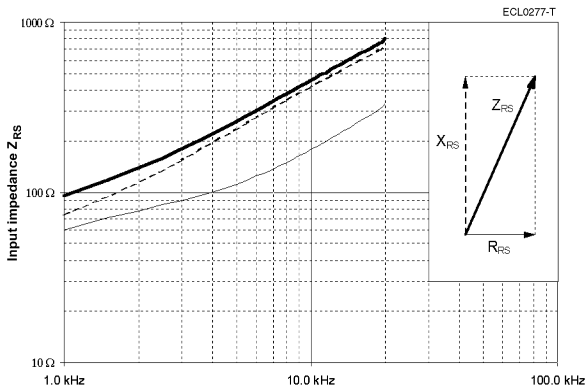
$R_{R1\text{-}R2}$ = 24 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 58 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

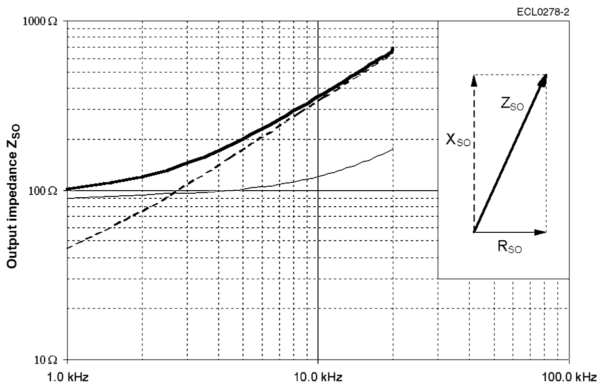


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

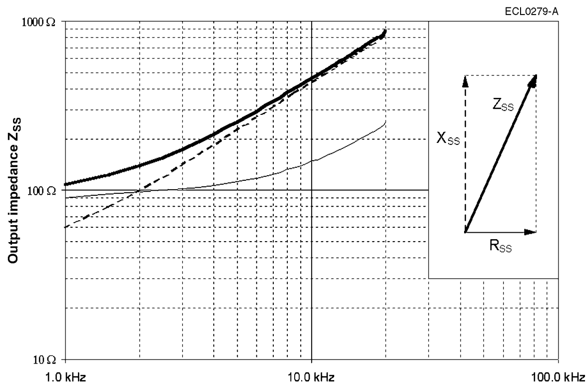


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 7.9 mH
L_{SS} = 6.9 mH

V23401-T 2009-B2..
V23401-H2009-B2..
with low output impedance

Housing	Aluminum	V23401-T 2009-B2..
	CrNi-steel	V23401-H2009-B2..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T2009-B214	V23401-H2009-B214
± 15′	V23401-T2009-B222	V23401-H2009-B222
± 10′	V23401-T2009-B201	V23401-H2009-B201
± 7′	V23401-T2009-B202	V23401-H2009-B202
Residual voltage $V_{residual}$	14 mV at $V_{R1\text{-}R2}$ = 4 V	

Electrical data at 22 °C.

Transfer function

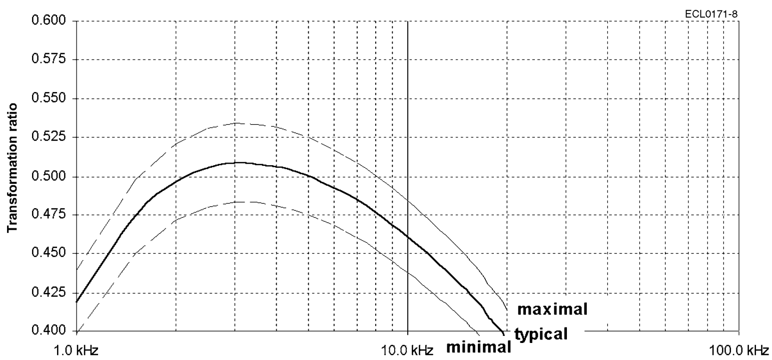
Pairs of poles p: p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\,max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\,max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 2 ... 8 kHz
= 0.5 ± 5 % at 5 kHz



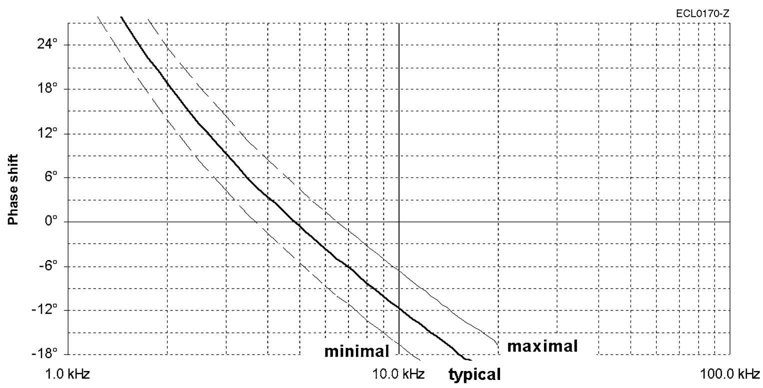
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

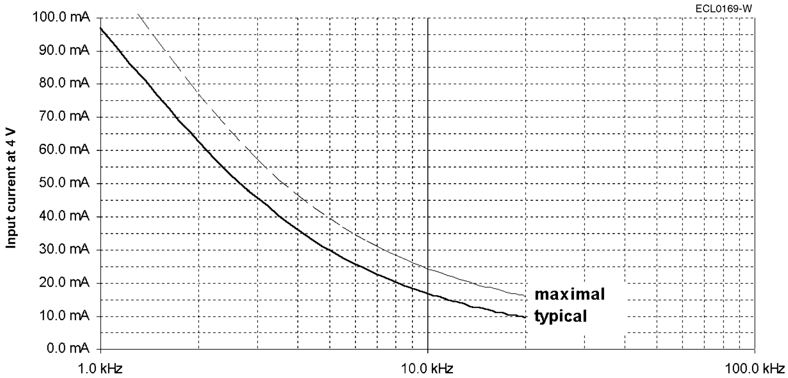
Input voltage V_{R1-R2}, typical	2 V_{rms} ... 8 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 4\ V$

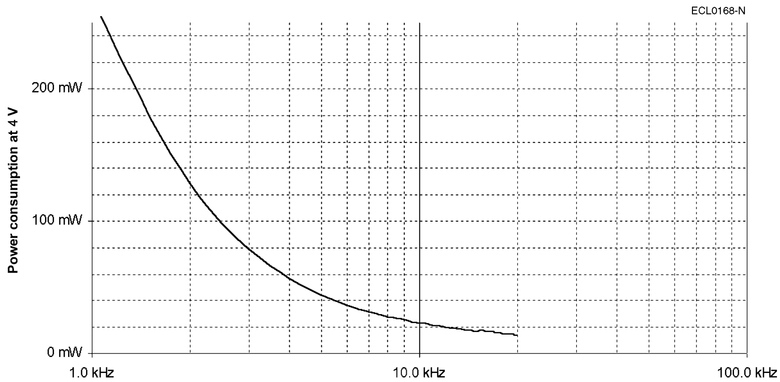


Power consumption P

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 4\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

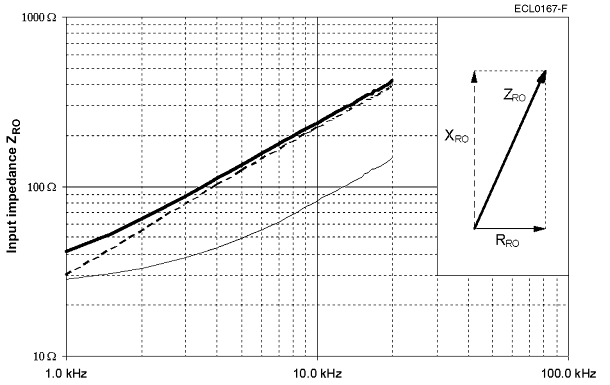
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

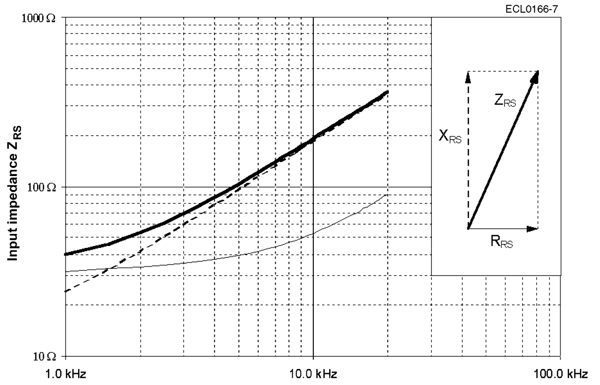
$R_{R1\text{-}R2}$ = 21 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 22 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

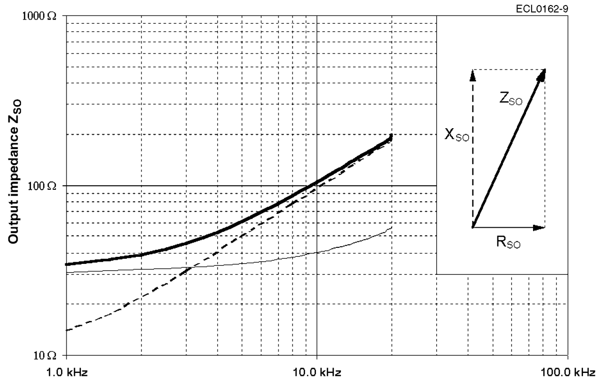


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

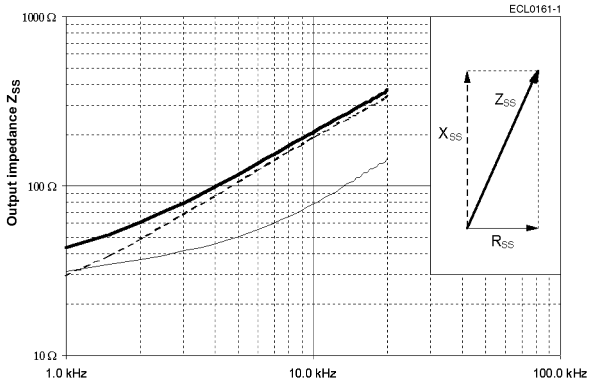


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 3.5 mH
L_{SS} = 3.1 mH

Size 21

Hollow Shaft Resolver Size 21

V23401-T 2010-B2..
V23401-H2010-B2..
3-speed

Housing	Aluminum CrNi-steel	V23401-T 2010-B2.. V23401-H2010-B2..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**	
	Aluminum housing	CrNi-steel housing
± 20′	V23401-T2010-B214	V23401-H2010-B214
± 15′	V23401-T2010-B222	V23401-H2010-B222
± 10′	V23401-T2010-B201	V23401-H2010-B201
± 7′	V23401-T2010-B202	V23401-H2010-B202
Residual voltage $V_{residual}$	20 mV at $V_{R1\text{-}R2}$ = 6 V	

Electrical data at 22 °C.

Transfer function

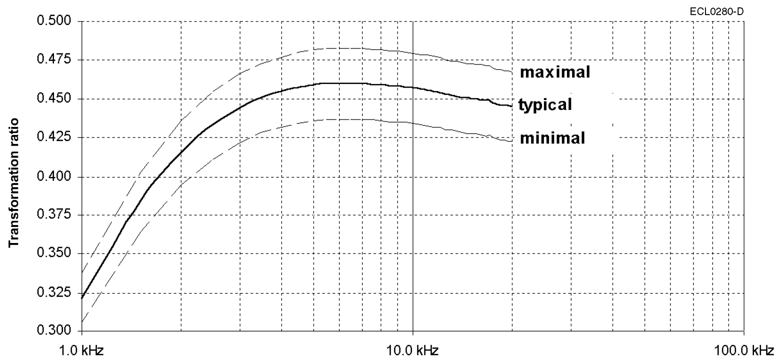
Pairs of poles p: p = 3

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.46 ± 10 % within 3 ... 20 kHz
= 0.46 ± 5 % at 6 kHz



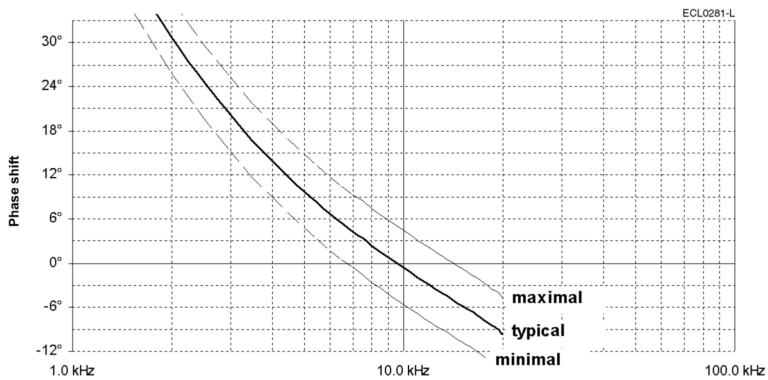
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

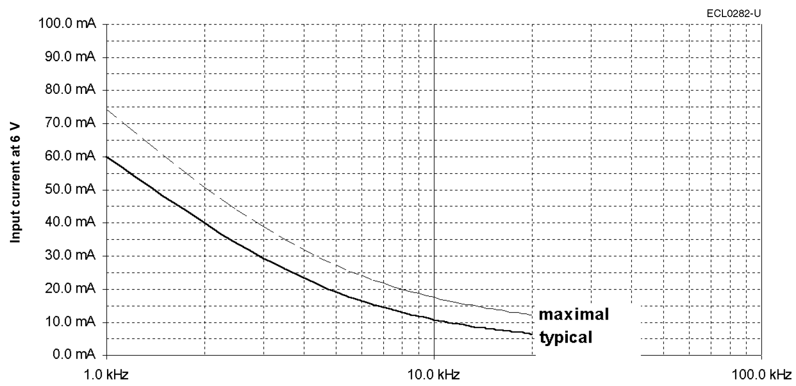
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤0.5 W is not critical.
Frequency f, typical	4 kHz ... 15 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 6\ V$

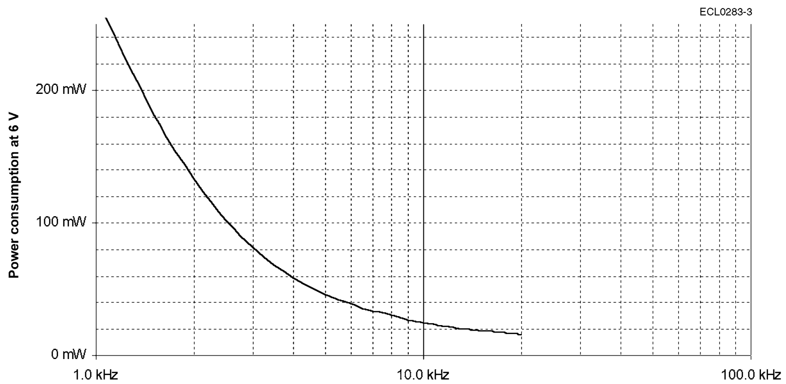


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 6\ V)^2$



Resistance, impedance and operating parameters (continued)

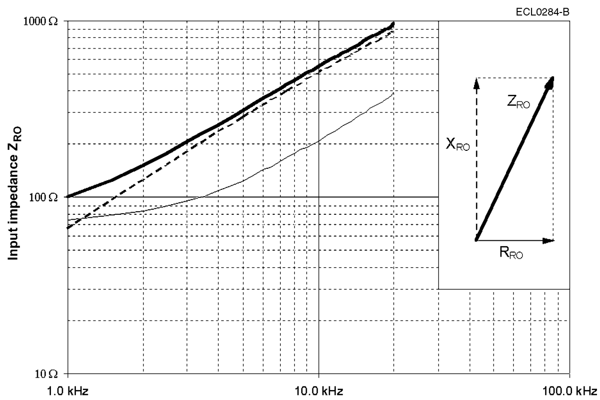
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

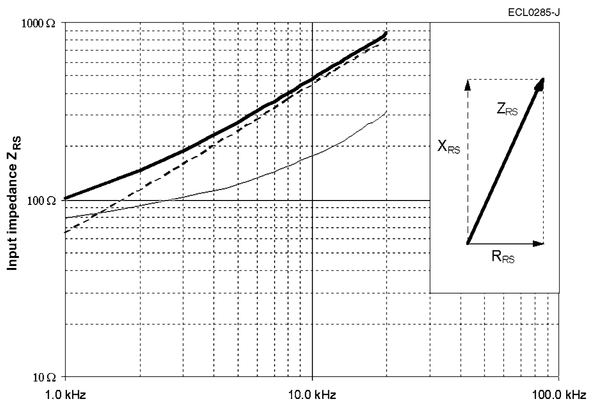
$R_{R1\text{-}R2}$ = 55 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 173 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

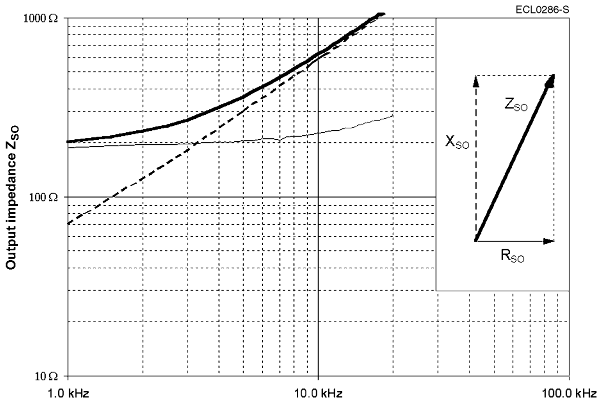


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

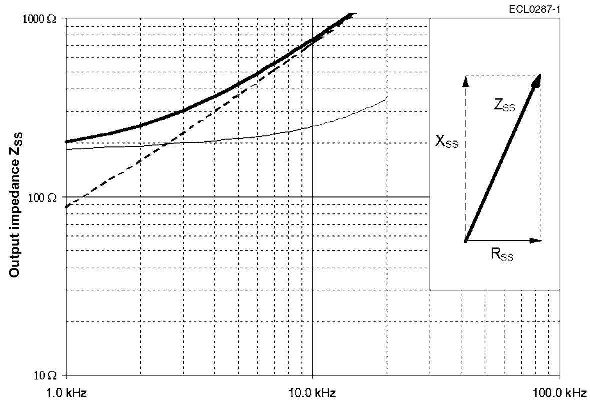


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 8.1 mH
L_{SS} = 11.4 mH

Size 21

Hollow Shaft Resolver Size 21

V23401-T 2014-B2..
V23401-H2014-B2..
4-speed

Housing	Aluminum	V23401-T 2014-B2..
	CrNi-steel	V23401-H2014-B2..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T2014-B214	V23401-H2014-B214
± 15′	V23401-T2014-B222	V23401-H2014-B222
± 10′	V23401-T2014-B201	V23401-H2014-B201
± 7′	V23401-T2014-B202	V23401-H2014-B202
Residual voltage $V_{residual}$	20 mV at $V_{R1\text{-}R2}$ = 6 V	

Electrical data at 22 °C.

Transfer function

Pairs of poles p

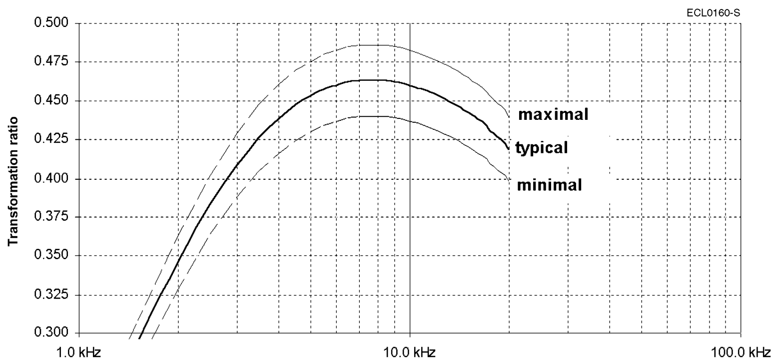
p = 4

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\,max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\,max} / V_{R1\text{-}R2}$

= 0.46 ± 10 % within 4 ... 15 kHz
= 0.46 ± 5 % at 6 kHz



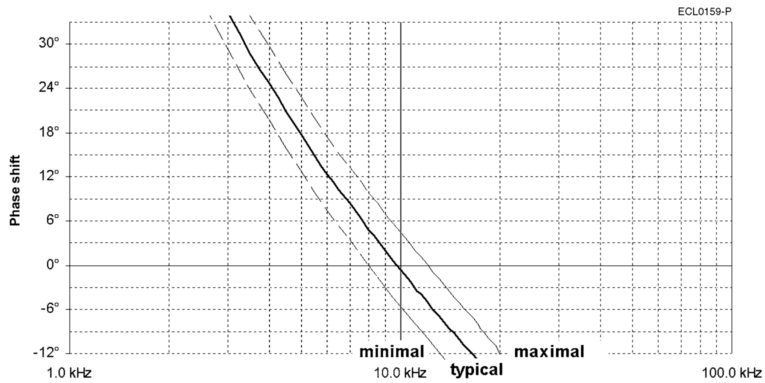
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

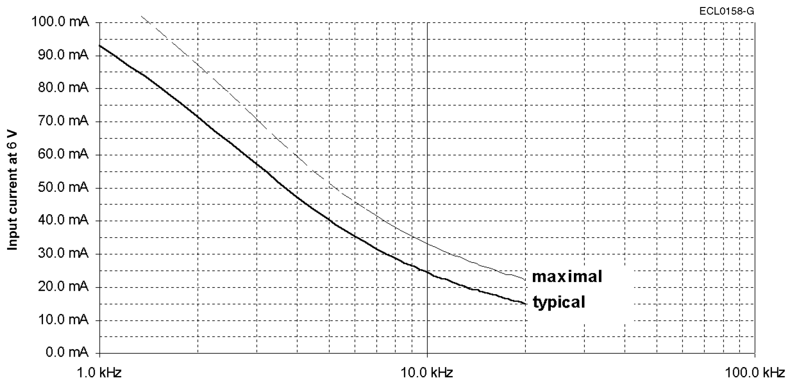
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of $P \leq 0.5$ W is not critical.
Frequency f, typical	4 kHz ... 15 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 6\ V$

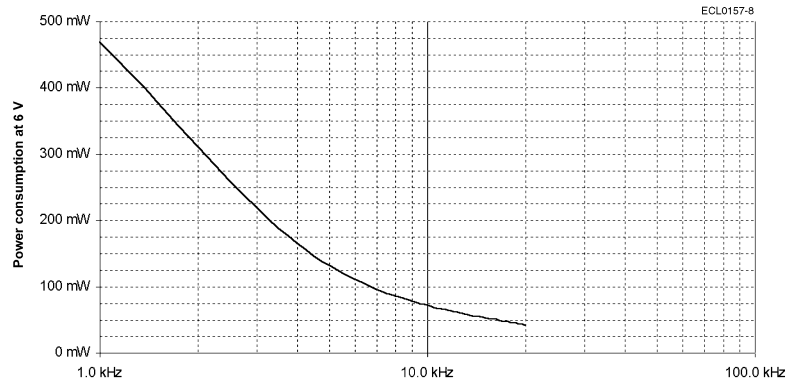


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 6\ V)^2$



Resistance, impedance and operating parameters (continued)

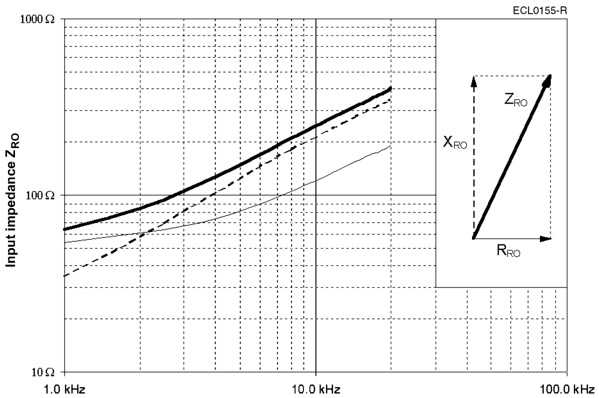
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

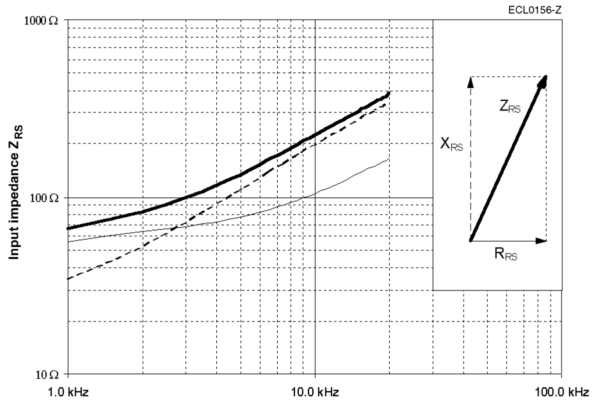
$R_{R1\text{-}R2}$ = 36 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 48 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

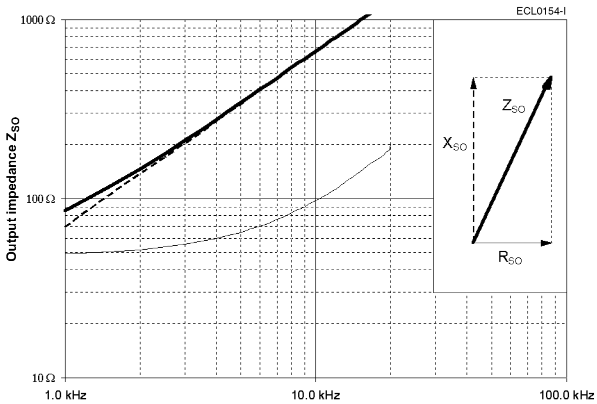


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

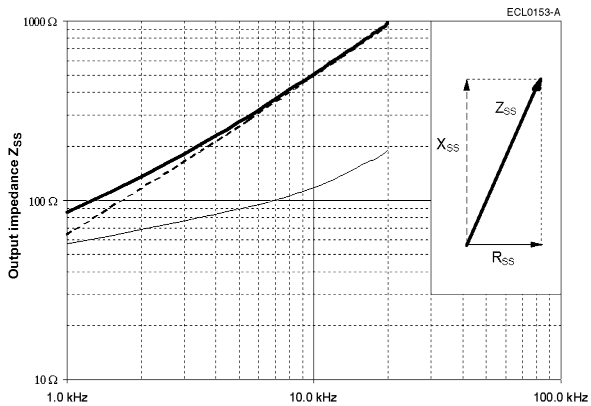


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 3.4 mH
L_{SS} = 7.8 mH

Housing	Aluminum	V23401-T 2015-B2..
	CrNi-steel	V23401-H2015-B2..

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code** Aluminum housing	CrNi-steel housing
± 20′	V23401-T2015-B214	V23401-H2015-B214
± 15′	V23401-T2015-B222	V23401-H2015-B222
± 10′	V23401-T2015-B201	V23401-H2015-B201
± 7′	V23401-T2015-B202	V23401-H2015-B202
Residual voltage $V_{residual}$	21 mV at $V_{R1\text{-}R2}$ = 6 V	

Electrical data at 22 °C.

Transfer function

Pairs of poles p

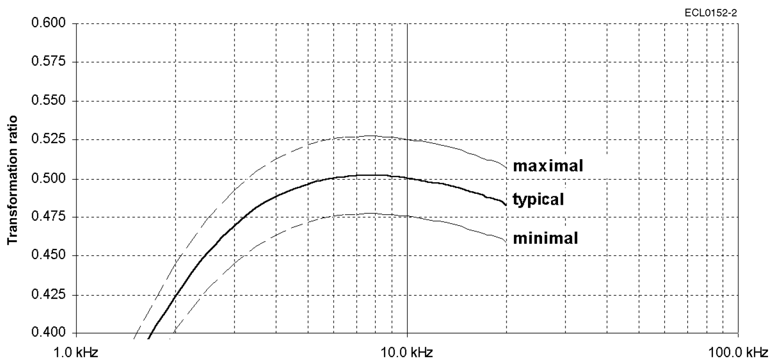
p = 2

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$

= 0.5 ± 10 % within 4 ... 20 kHz
= 0.5 ± 5 % at 10 kHz



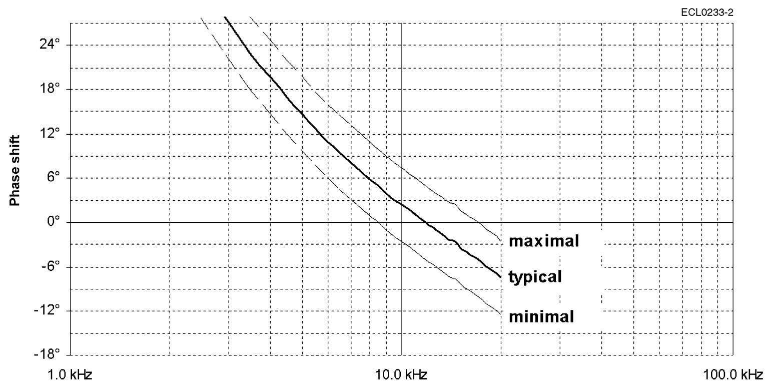
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Resistance, impedance and operating parameters

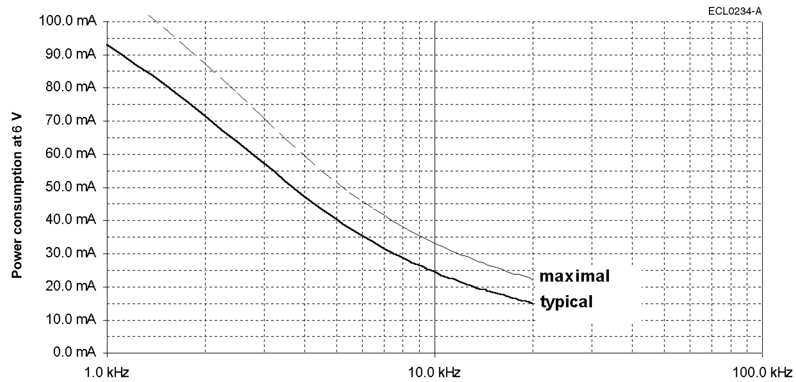
Input voltage V_{R1-R2}, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	4 kHz ... 15 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 6 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 6\ V$

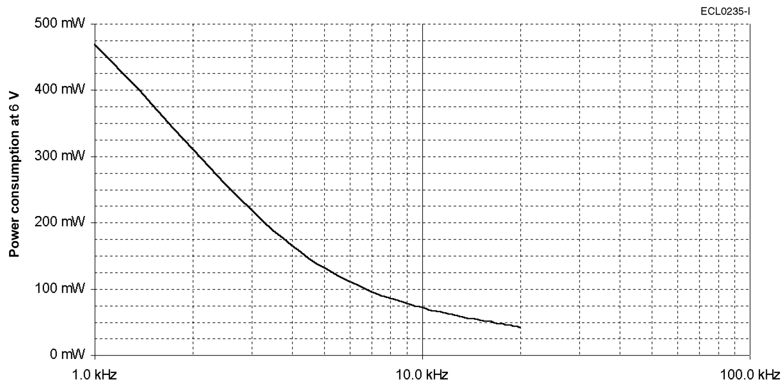


Power consumption P

The adjacent figure applies to V_{R1-R2} = 6 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 6\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

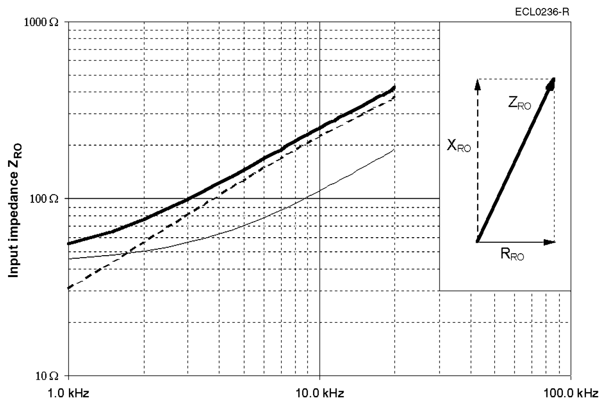
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

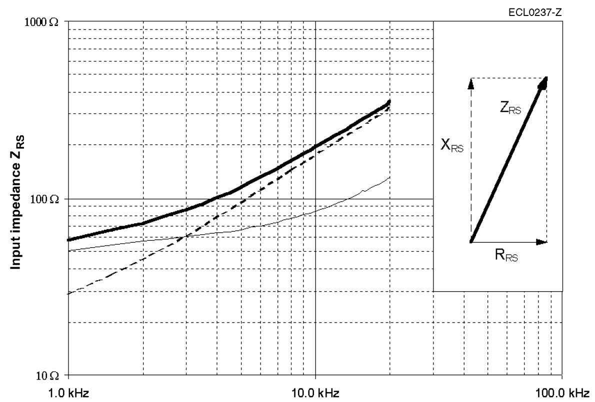
$R_{R1\text{-}R2}$ = 33 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 30 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

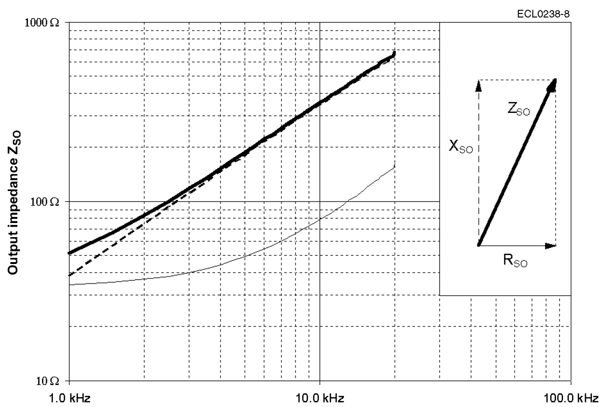


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

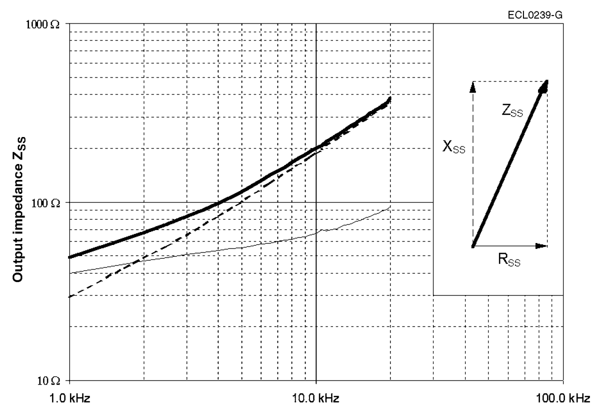


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 10 kHz

L_{RO} = 3.6 mH
L_{SS} = 3.0 mH

Housing	CrMo-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 10′	V23401-U1016-B101
± 8′	V23401-U1016-B109
± 6′	V23401-U1016-B110
± 4′	V23401-U1016-B133
Residual voltage $V_{residual}$	14 mV at $V_{R1\text{-}R2} = 4$ V

Electrical data at 22 °C.

Transfer function

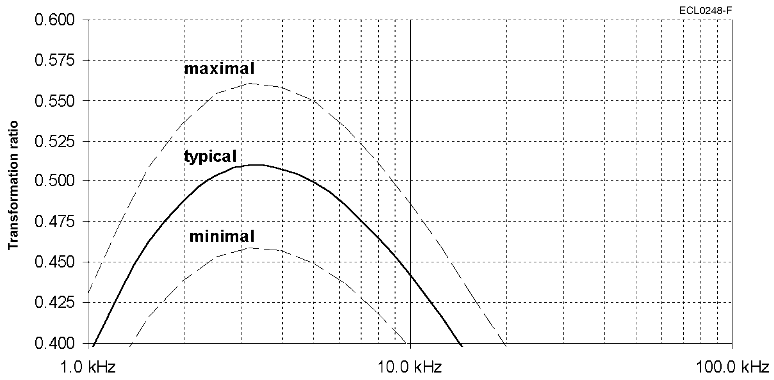
Pairs of poles p	p = 1

Transformation ratio r_T

$r_T = V_{S1\text{-}S3\,max} / V_{R1\text{-}R2}$

$= V_{S2\text{-}S4\,max} / V_{R1\text{-}R2}$

= 0.5 ± 20 % within 1.5 ... 10 kHz
= 0.5 ± 10 % at 5 kHz



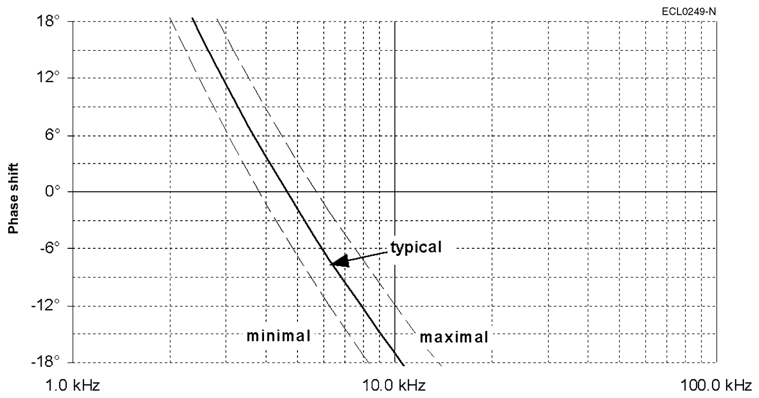
Phase shift ψ

$V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$

$V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\,max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$

for $-90° < \alpha < +90°$

Tolerance: ± 5°



Size 21

Resistance, impedance and operating parameters

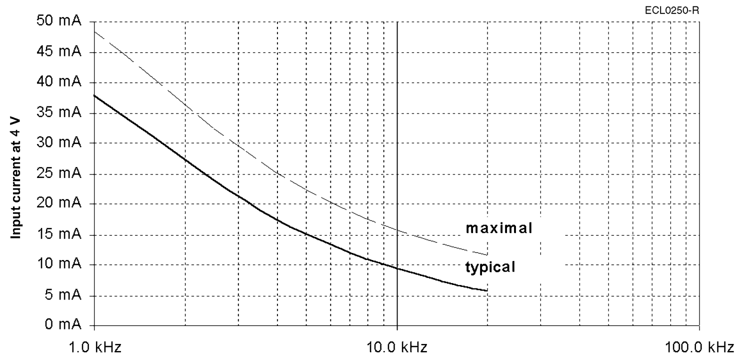
Input voltage V_{R1-R2}, typical	2 V_{rms} ... 20 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1-R2} / 4\ V$

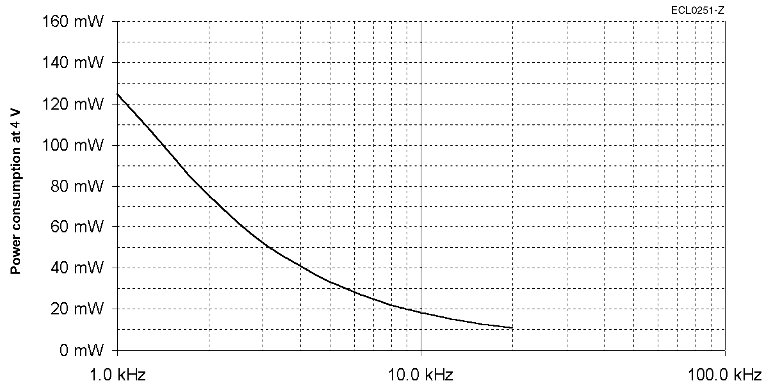


Power consumption P

The adjacent figure applies to V_{R1-R2} = 4 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1-R2} / 4\ V)^2$



Resistance, impedance and operating parameters (continued)

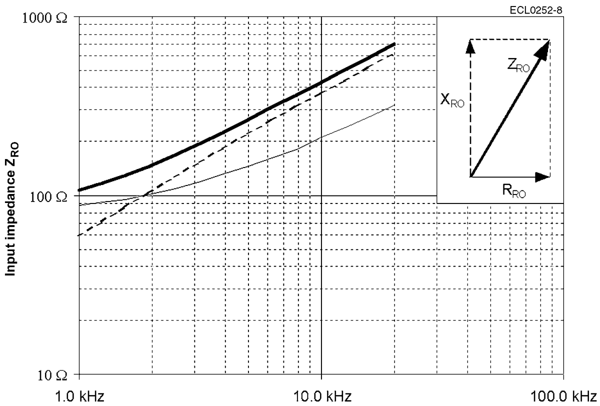
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

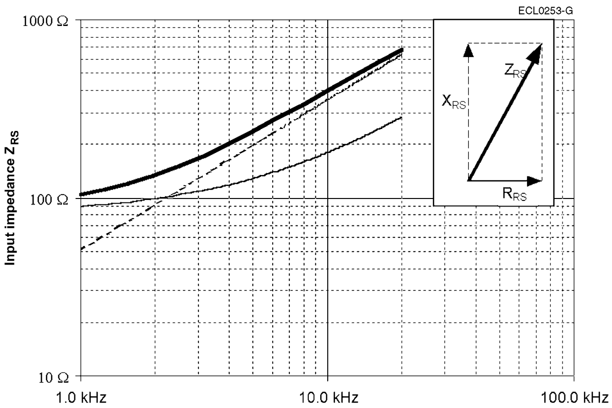
$R_{R1\text{-}R2}$ = 65 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 81 Ω
Tolerance: ± 15 %

Input impedance

Tolerance: ± 20 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

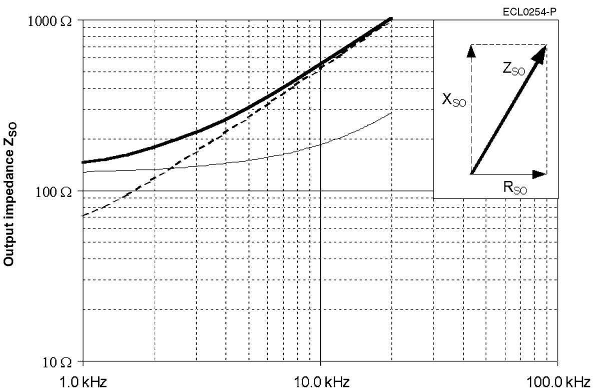


Tolerance: ± 20 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

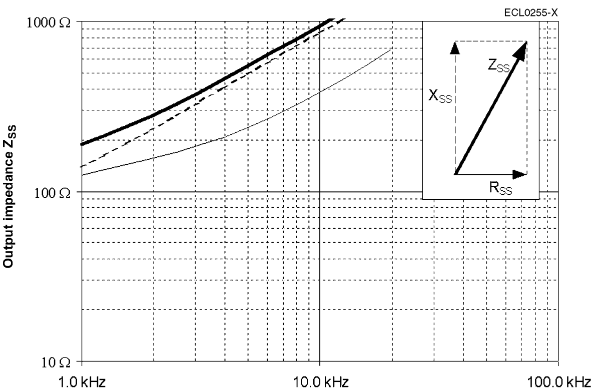


Output impedance

Tolerance: ± 20 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 20 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 5 kHz

L_{RO} = 6 mH
L_{SS} = 13 mH

Size 21

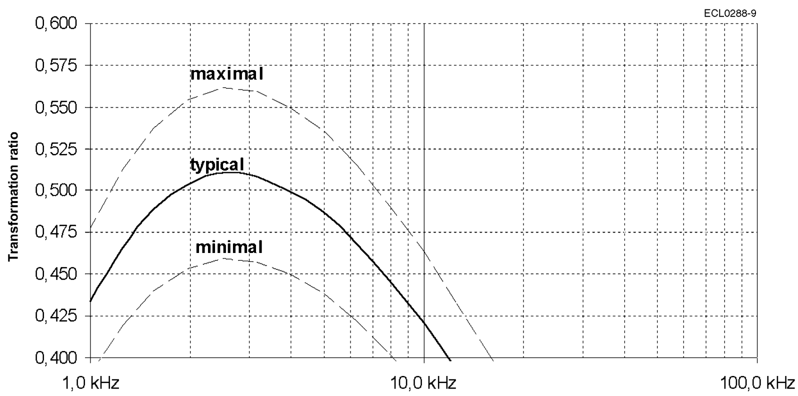
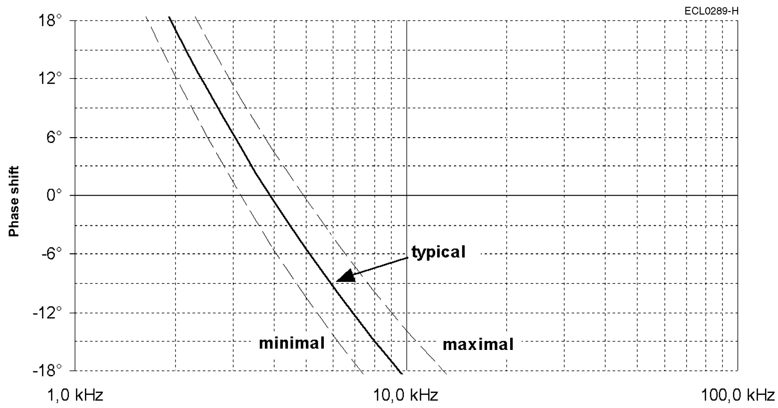
Housing	CrMo-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 10′	V23401-U2017-B201
± 7′	V23401-U2017-B202
± 4′	V23401-U2017-B233
Residual voltage $V_{residual}$	18 mV at $V_{R1\text{-}R2}$ = 5 V

Electrical data at 22 °C.

Transfer function

Pairs of poles p	p = 1
Transformation ratio r_T $r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$ $= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$ = 0.5 ± 20 % within 1 ... 10 kHz = 0.5 ± 10 % at 4 kHz	
Phase shift ψ $V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$ $V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$ for $-90° < \alpha < +90°$ Tolerance: ± 5°	

Size 21

Resistance, impedance and operating parameters

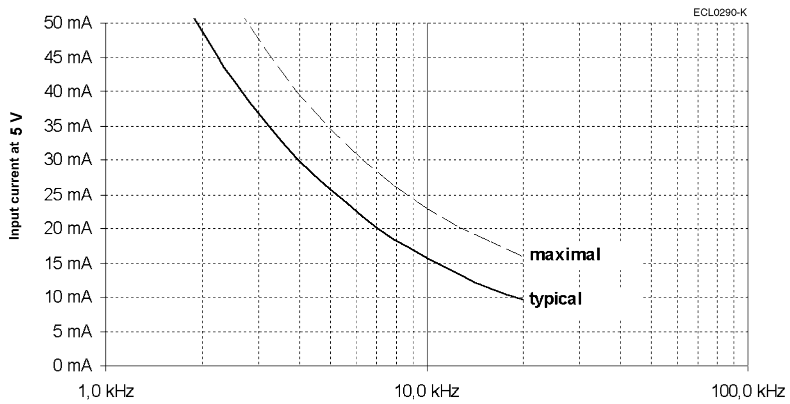
Input voltage $V_{R1\text{-}R2}$, typical	$4\ V_{rms}$ ... $20\ V_{rms}$	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of $P \leq 0.5$ W is not critical.
Frequency f, typical	2 kHz ... 10 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2} = 5$ V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 5\ V$

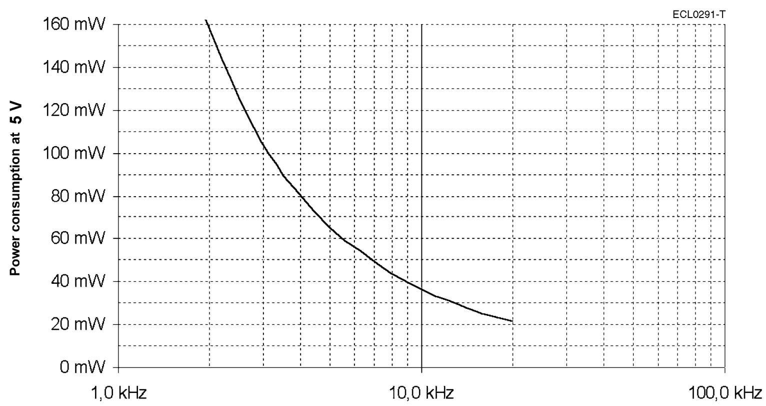


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2} = 5$ V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 5\ V)^2$



Size 21

Resistance, impedance and operating parameters (continued)

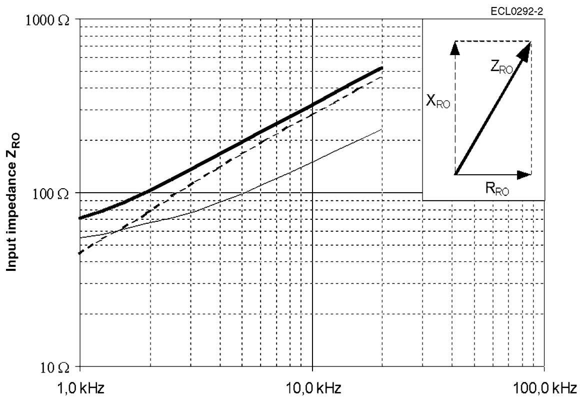
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

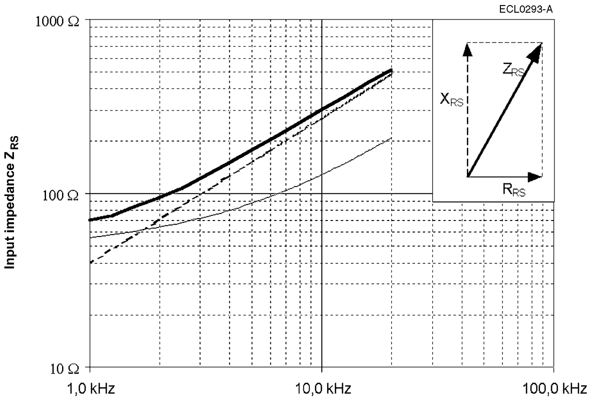
$R_{R1\text{-}R2}$ = 36 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 56 Ω
Tolerance: ± 15 %

Input impedance

Tolerance: ± 20 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

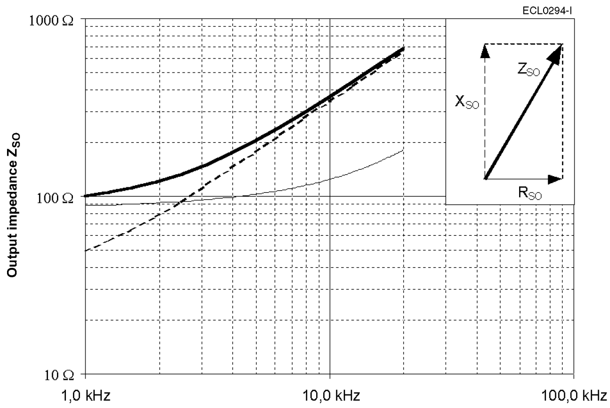


Tolerance: ± 20 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

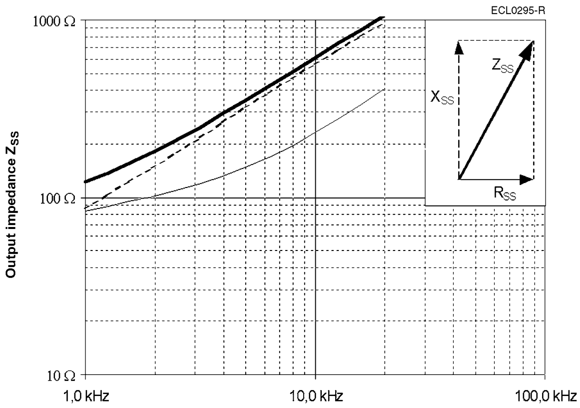


Output impedance

Tolerance: ± 20 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 20 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 4 kHz

L_{RO} = 5.5 mH
L_{SS} = 10.5 mH

Size 21

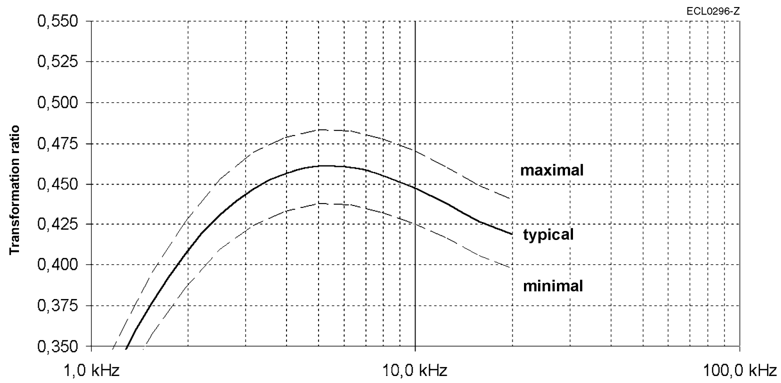
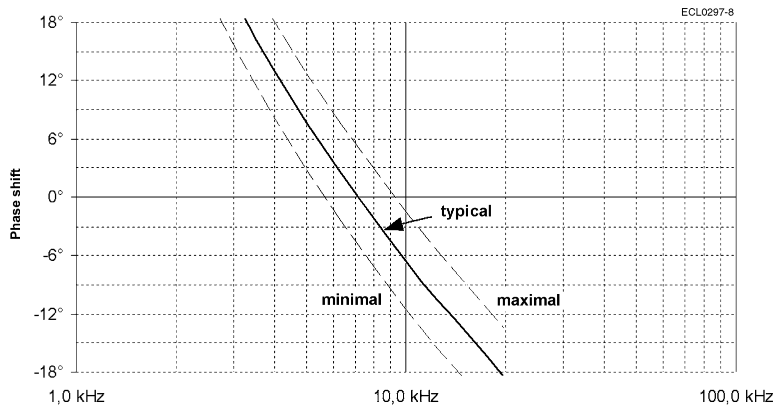
Housing	CrMo-steel

Electrical error / Ordering information

Angular error spread $\Delta\varphi$	**Ordering code**
± 10′	V23401-U2020-B201
± 8′	V23401-U2020-B209
± 6′	V23401-U2020-B210
Residual voltage $V_{residual}$	20 mV at $V_{R1\text{-}R2}$ = 6 V

Electrical data at 22 °C.

Transfer function

Pairs of poles p	p = 3
Transformation ratio r_T $r_T = V_{S1\text{-}S3\ max} / V_{R1\text{-}R2}$ $= V_{S2\text{-}S4\ max} / V_{R1\text{-}R2}$ = 0.5 ± 10 % within 3 ... 10 kHz = 0.5 ± 5 % at 6 kHz	
Phase shift ψ $V_{R1\text{-}R2}(t) = V_{R1\text{-}R2\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t)$ $V_{S1\text{-}S3}(t) = V_{S1\text{-}S3\ max} \cdot \sin(2 \cdot \pi \cdot f \cdot t - \psi)$ for –90° < α < +90° Tolerance: ± 5°	

Resistance, impedance and operating parameters

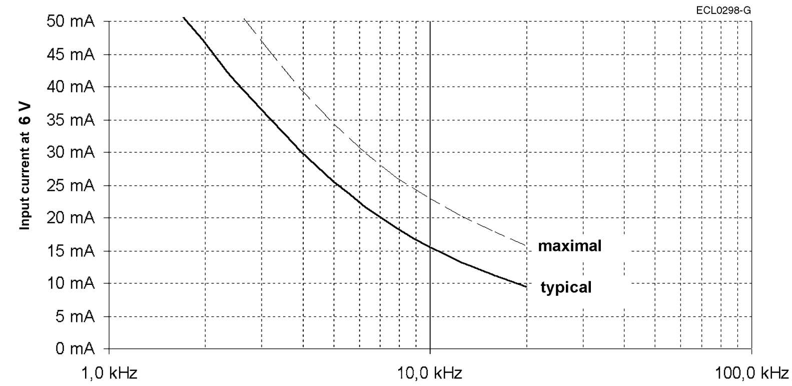
Input voltage $V_{R1\text{-}R2}$, typical	2 V_{rms} ... 10 V_{rms}	When choosing the values of these parameters take into account power dissipation, max. ambient temperature and the heat dissipation. Including self heating a maximum operating temperature of 150 °C must not be exceeded. Generally a power dissipation of P ≤ 0.5 W is not critical.
Frequency f, typical	4 kHz ... 10 kHz	

Input current I

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the input current changes follows as:

$I = I_{Figure} \cdot V_{R1\text{-}R2} / 6\ V$

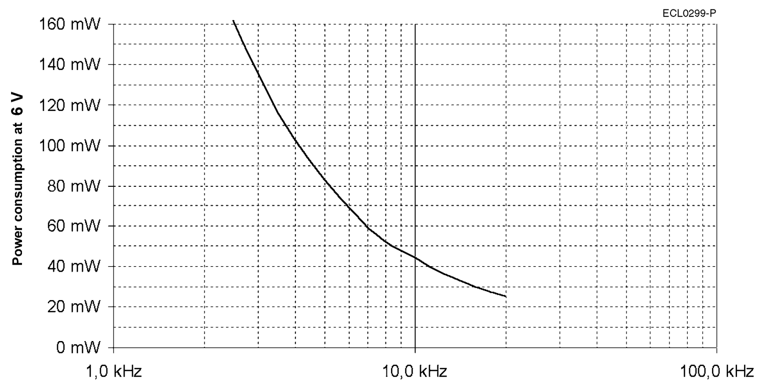


Power consumption P

The adjacent figure applies to $V_{R1\text{-}R2}$ = 6 V.

For other input voltages, the power consumption changes follows as:

$P = P_{Figure} \cdot (V_{R1\text{-}R2} / 6\ V)^2$



Resistance, impedance and operating parameters (continued)

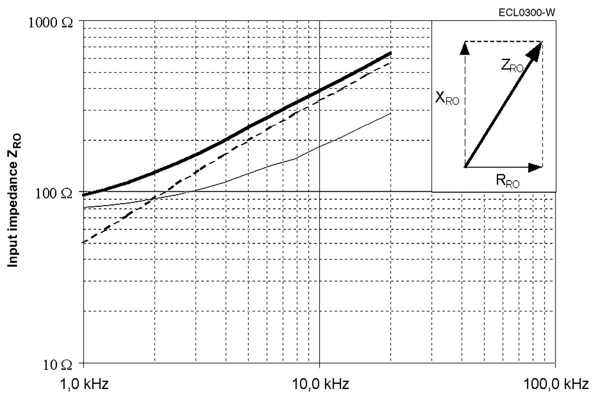
DC resistance

The ohmic resistance values are based on an ambient temperature of 22 °C and change with temperature by 0.39 % / K

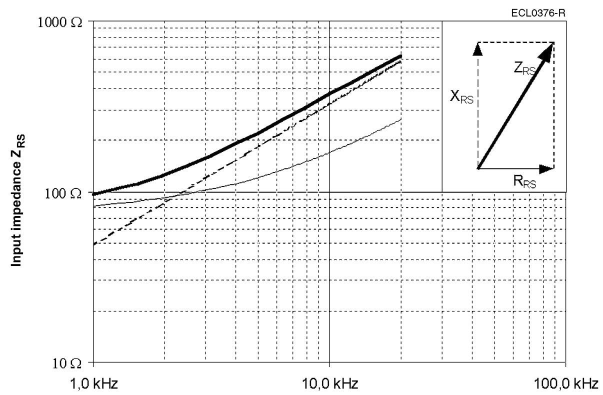
$R_{R1\text{-}R2}$ = 62 Ω
$R_{S1\text{-}S3}$ = $R_{S2\text{-}S4}$ = 186 Ω
Tolerance: ± 10 %

Input impedance

Tolerance: ± 15 %
Z_{RO} ... Impedance between R1 and R2 with open outputs

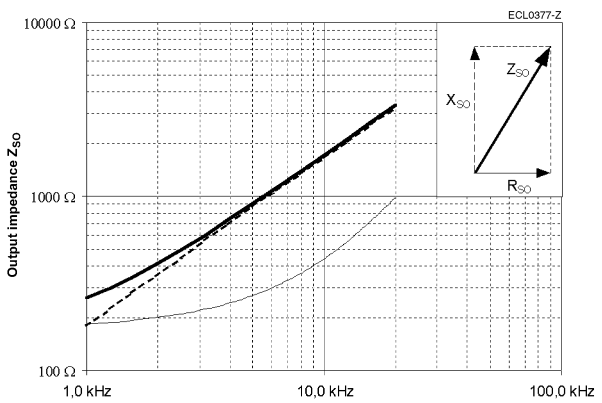


Tolerance: ± 15 %
Z_{RS} ... Impedance between R1 and R2 with short circuits between S1 and S3 as well as between S2 and S4

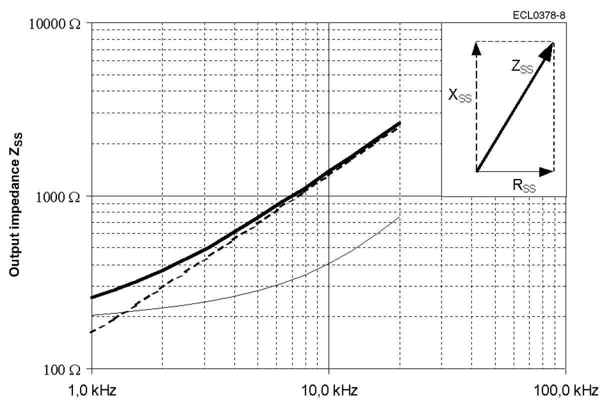


Output impedance

Tolerance: ± 15 %
Z_{SO} ... Impedance between S2 and S4 in a position of 0° (minimal coupling) with open outputs



Tolerance: ± 15 %
Z_{SS} ... Impedance between S1 and S3 in a position of 0° (max. coupling) with short circuits between R1 and R2



Inductance L

$L = X / (2 \cdot \pi \cdot f)$
at f = 6 kHz

L_{RO} = 4 mH
L_{SS} = 14 mH

Engineering Notes

Size 21

Americas

Argentina – Buenos Aires
Phone: +54-1-733-2000
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Brasil – São Paulo
Phone: +55-11-3611-1311
Fax: +55-11-3611-0397

Canada – Toronto
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Fax: +905-474-5520

Chile – Santiago
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Colombia – Bogota
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Fax: +57-1-240-3769

Mexico – Mexico City
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Fax: +52-5-361-8545

United States – Harrisburg, PA
Phone: +717-564-0100
Fax: +717-986-7575

Venezuela – Caracas
Phone: +58-2-986-7774
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For Latin/South American Countries not shown
Phone: +54-11-4733-2015
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Asia/Pacific

Australia – Sydney
Phone: +61-2-9840-8200
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India – Bangalore
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Indonesia – Jakarta
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Japan – Kawasaki, Kanagawa
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Korea – Seoul
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Austria – Vienna
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Fax: +32-16-352-352

Bulgaria – Sofia
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Phone: +420-5-41-162-111
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Fax: +372-6205-980

Finland – Helsinki
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Fax: +33-1-3420-8600

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Export – St Ouen L'Aumone
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SIMEL – Gevrey-Chambertin
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Germany – Bensheim
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