VAC VACUUMSCHMELZE	**Specification**	**Item no.:**	**T60404-P4640-X256**

K-no.: K26928	**1700A Current Sensor for ±24V supply with a transformation ratio of K_N=1:5000** for electric current measurement: DC, AC, pulsed, mixed ..., with a galvanic isolation between primary circuit (high power) and secondary circuit (electronic circuit)	Date: 08.09.2021

Customer: Standard type	Customers Part no.:	Page 1 von 8

Electrical Data – Ratings

I_{PN}	Primary nominal r.m.s. current	1700	A
R_M [1)]	Measuring resistance for I_{PN_DC} @ 85°C	0 ... 30	Ω
I_{SN}	Secondary nominal r.m.s. or DC current	340	mA
K_N [2)]	Turns ratio	(1): 5000	

[1)] for the max. measuring range depending on R_M please refer to Fig.2

[2)] first number in brackets represents the count of primary turns guided through the primary opening of the sensor

Accuracy – Dynamic performance data

		min.	typ.	max.	Unit
$I_{P,max}$[1)]	measuring range @ R_M = 1 Ω; ϑ_A= 20°C; U_C=±24V	3400			A
	@ R_M = 1 Ω; ϑ_A= 85°C; U_C=±24V	2750			A
X	Accuracy @ I_{PN} for ϑ_A= 25°C			0.3	%
X_{Ti}	Temperature drift of X @ ϑ_A = -40 ... +85 °C (secondary)			0.1	%
ε_L	Linearity			0.1	%
I_{S0}	Offset current (secondary) @ I_P=0A, ϑ_A= 25°C			0.1	mA
I_{S0H}	Hysteresis current (secondary)			0.1	mA
t_r	Response time @ 90% of I_{PN}		< 0.5		µs
Δt ($I_{P, max}$)	Delay time @ 10% of I_{PN} (at di/dt = 600A/µs)			0.5	µs
f_{BW}	Frequency bandwidth (small signal)	DC…100			kHz

[1)] for $I_{P,max}$ see Fig. 1 on Page 2, short term currents with high slew rates can be measured above $I_{P,max,}$ (transformer behavior)

General data

		min.	typ.	max.	Unit
ϑ_A [1)]	Ambient operating temperature	-40		+85	°C
ϑ_S	Ambient storage temperature acc. VAC M3101	-45		+100	°C
m	Mass		550		g
U_C	Supply voltage	±22.8	±24	±25.2	V
I_{C0}	Current consumption for Ip = 0A		±31		mA
I_{CN} [2)]	Current consumption for I_{PN} = 1500A	270	310	375	mA

[1)] The temperature of the sensor surface at any position must not exceed 105°C

[2)] Due to the Class-D final stage used for generating the compensation current, the supply current I_{CN} (I_C @ I_P = I_{PN}) is lower than I_{SN}. The specified wide range of the supply current is reasoned by dependencies on ambient operating temperature ϑ_A and the value of the resistor R_M connected to the sensor output.

s_{clear} [3)]	Clearance distance		22		mm
s_{creep} [3)]	Creepage distance		22		mm
U_{sys} [3)]	System voltage	reinforced insulation		1000	V_{RMS}
		basic insulation		3127	V_{RMS}
U_{sys} [3)]	Working voltage	reinforced insulation		1000	V_{RMS}
		basic insulation		4400	V_{RMS}
U_{PD} [3)]	Rated discharge voltage			1414	V_{PEAK}
	Maximum potential Difference acc. to UL 508			1000	V_{RMS}

[3)] Constructed and manufactured and tested in accordance with IEC 61800-5-1:2007 (secondary pins 1, 2 and 3 to primary opening) Insulation material group 1, Pollution degree 2, Overvoltage category III, altitude ≤ 2000m

Date	Name	Issue	Amendment
		81	

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Measurement Range Derating

In addition to the sensor design and construction, following operating parameters have high influence to the measurement range limit I_{Pmax}: the actual continuous primary current I_P, the burden resistor R_M, the ambient temperature ϑ_A, the supply voltage $\pm U_C$ and the busbar temperature. (following curves are interpolated calculations verified by sample measurements)

Derating depending on primary current I_P:

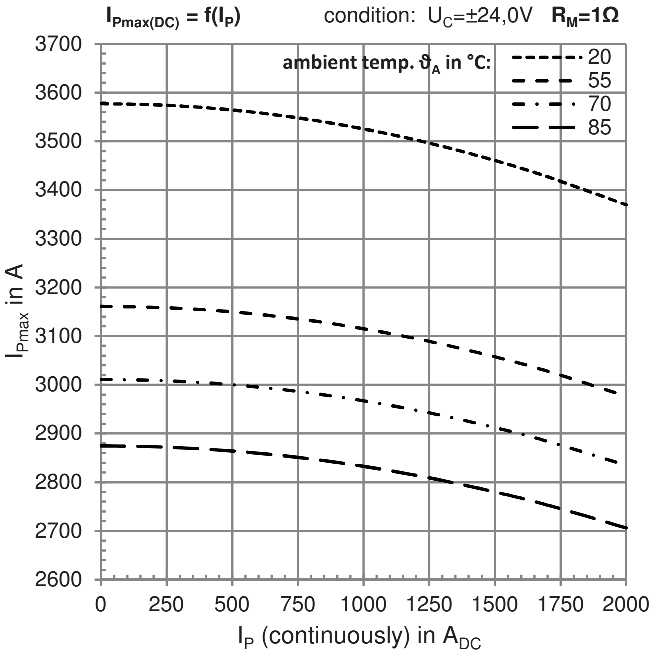


Fig. 1: measureable current I_{Pmax} depending on the primary continuous current I_p

Derating depending on connected burden resistor R_M:

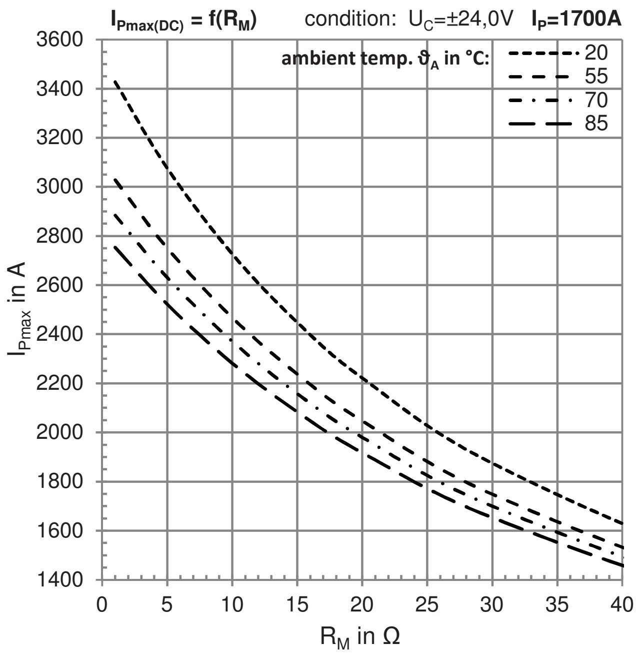


Fig. 2: measureable currents I_{Pmax} depending on the burden resistor R_M

Dwell Time Limits For Maximum DC Currents (I_{Pmax})

ϑ_A	ambient temperature	85			**°C**
R_M	burden resistor	1	5	10	**Ω**
$I_{Pmax(DC)}$	max. DC primary current	2750	2500	2260	A
t_{dwell}	**Permissible dwell time for $I_{Pmax(DC)}$**	**< 4**	**< 6**	**< 8**	**minutes**

Tab.1: permissible dwell times for measureable DC peak currents at 85°C without degradation of the sensor expected

after higher current loads ($I_p > I_{PN}$) recovery times should be taken into account.

Absolute Maximum Ratings For Continuous Currents*

ϑ_A	≤ 85°C
R_M	≥ 1Ω
I_P continuous	≤ 1800A_{DC}

* Exposure to this absolute maximum conditions for extended periods may degrade device reliability and lifetime. Stresses above these ratings may cause permanent damage. These are stress ratings. Functional operation of the device at these or any other conditions beyond those specified is not supported. This conditions don't comply with UL-Certification.

Tab.2: absolute maximum ratings for continuous currents with not to be excluded degradation and without UL-compliance

Supply Current Consumption

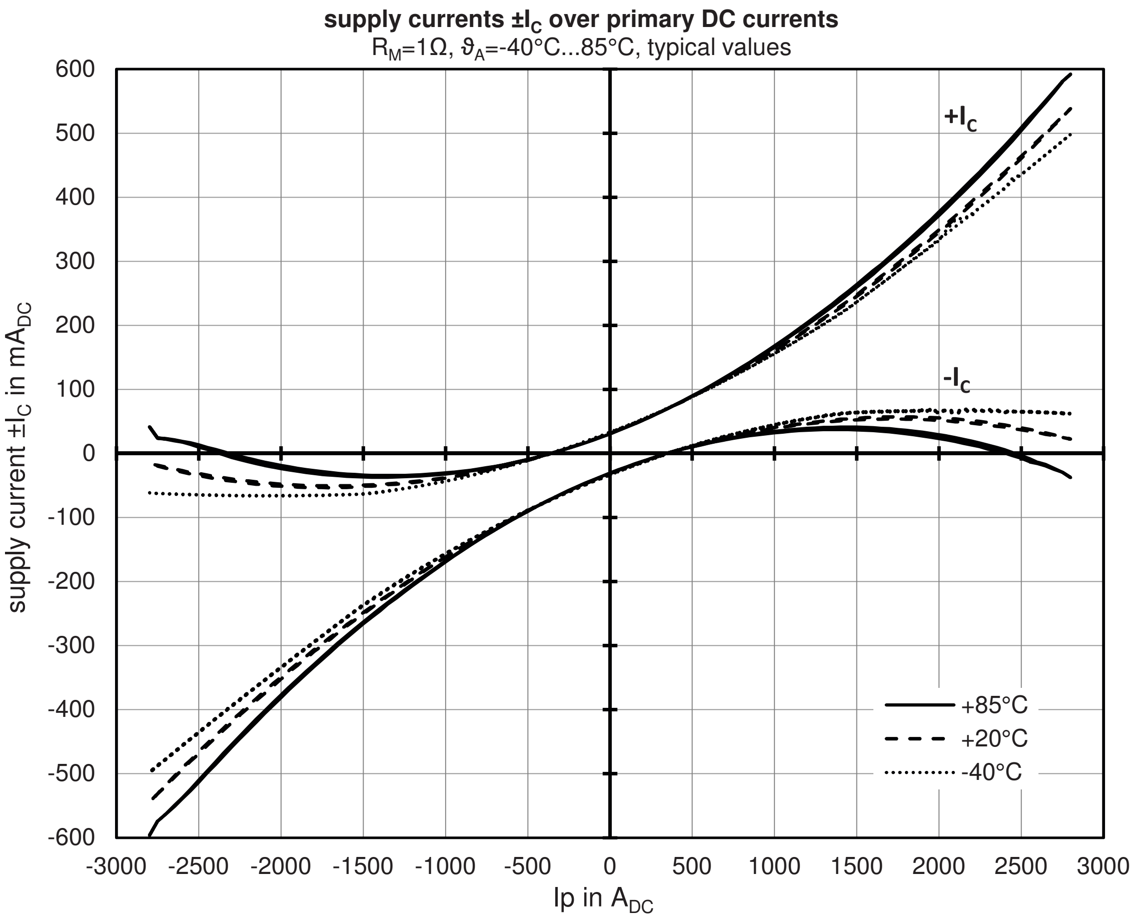


Fig. 5: supply current consumption (±I_C) at positive and negative supply voltage over primary current

Background information: "bus pumping effect"

For DC and low frequency measurements the output current of the sensor (or so called compensation current) is generated by a class D switching amplifier. the advantages of this thechnology are low power losses, meaning low self-heating of the sensor what makes a continuous measurement of high primary currents possible. Due to the principle of this technology, for I_P > +300A the negative supply current I_{C-} is getting positive and vice versa for I_P < -300A the positive supply current I_{C+} is getting negative as shown in Fig. 5. This effect reaches a maximum/minimum at a certain primary current depending on the operating temperature and the connected burden resistor R_M. It decreases by an increase of R_M or the operating temperature.

- reverse supply currents of the sensor can be used supply (partially) other loads connected to the same power supply
- sensors in three phase systems, where all sensors are connected to one power supply, the supply currents of the sensors can compensate each other similar to the behaviour of load currents in the star point of a three phase system (vector addition).

Noise And Offset Ripple Reduction

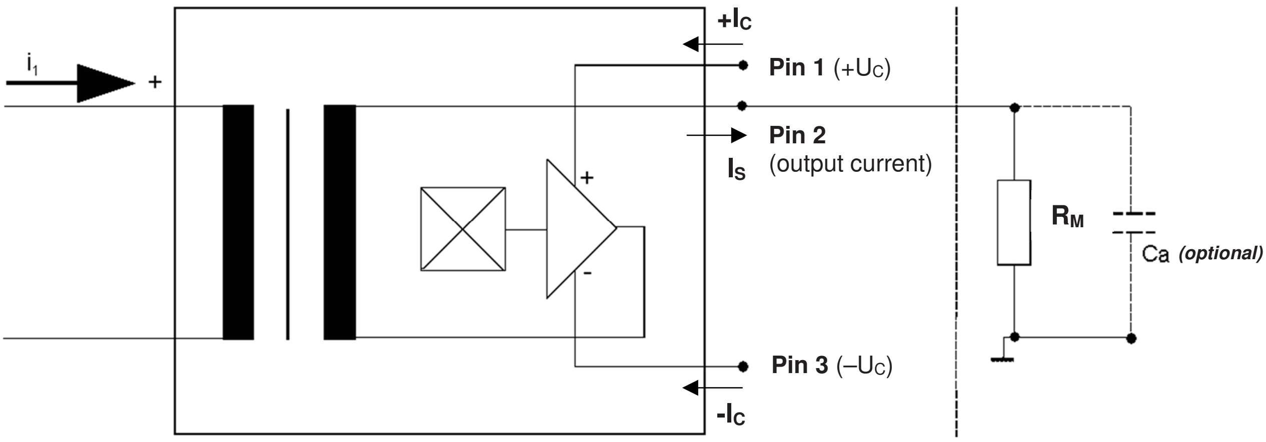
The offset ripple and noise can be reduced by an external low pass. The simplest solution is a passive low pass filter of 1st order with

$$f_g = \frac{1}{2\pi \cdot R_M \cdot C_a}$$

In this case the response time is enlarged. It is calculated from:

$$t_r' \geq t_r + 2.5 R_M C_a$$

Connection diagram



for information regarding connector type and pin assignment please refer to section „mechanical drawing“

Fig. 6: simplified schematic diagram of the sensor

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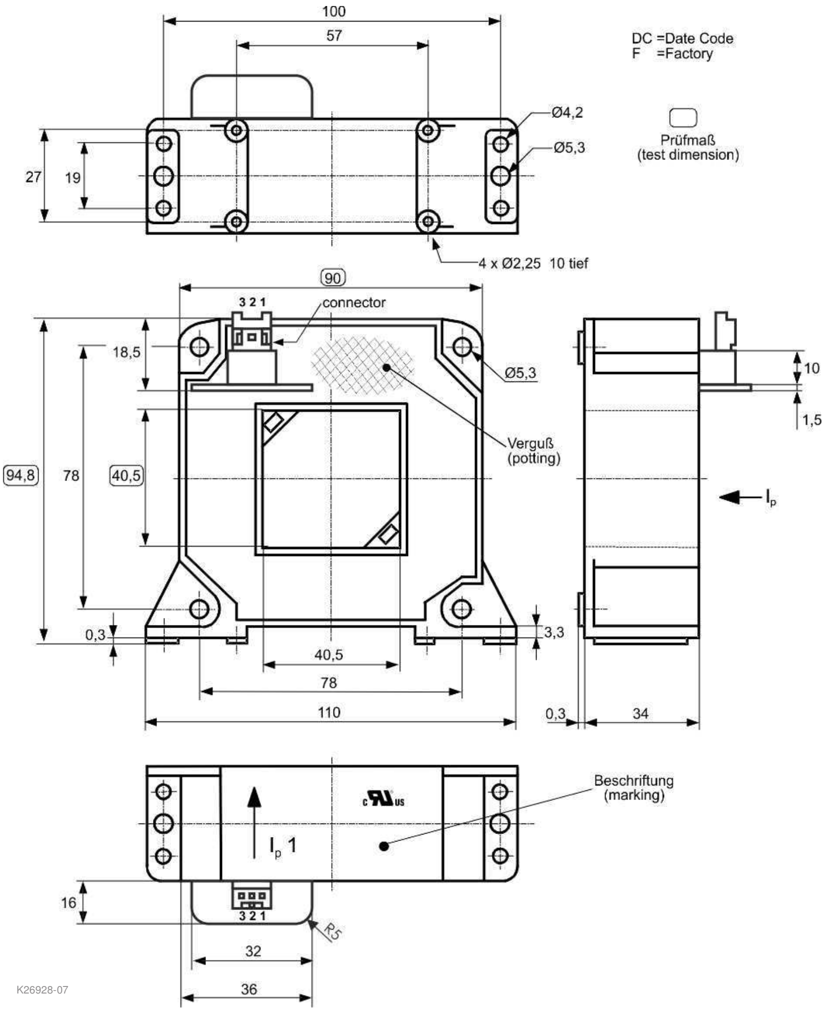
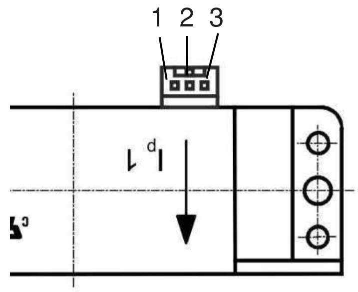
Mechanical outline (mm):

General tolerance DIN ISO 2768-c



Connector:

JST B03B-XASK-1

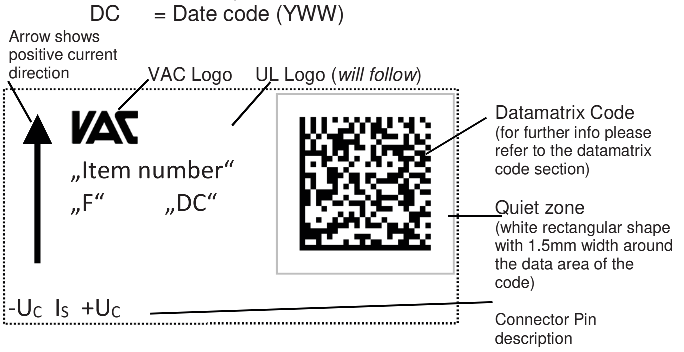


Pin Assignment:

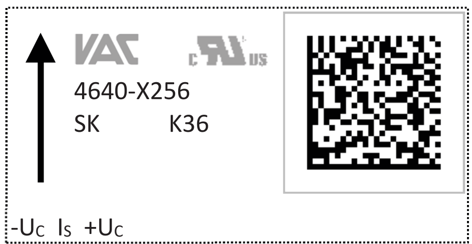
Pin 1: $+U_C$
Pin 2: I_S
Pin 3: $-U_C$

Marking

Explanation: Item number: see Tab.2 (left column)
F = Factory code
DC = Date code (YWW)



<u>Example</u>: Sensor with end number X256
Produced in Slovakia in CW38 2018
- *Part number: 4640-X256*
- *Factory code: SK*
- *Date code: K38*



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Datamatrix Code specification

Code Size:
metrical size: 18mm x 18mm
symbol size: 24 x 24 points
(additionally with a quite zone around the data area)

Code Content**:**
Standard: ANSI MH10.8.2

1T“**Batch-no.**“@1P“**Item-no.**“@2P“**datasheet revision**“@6D“**datecode**“@10V“**production site**“

1T**0001234567**@1P**T60404-P4640-X256**@2P**81**@6D**K36**@10V**SK**

Routine Test

Measurement after temperature balance of the samples at room temperature; SC = significant characteristic

$K_N(N_1/N_2)$	(100%) M3011/6	Transformation ratio (I_P=1500A, 40-80 Hz)	1 : 5000 ± 0.3	% (SC)
I_{S0}	(100%) M3226	Offset current	< 0.1	mA
U_P	(100%) M3014	Test voltage (1s) Pin 1,3,5 to primary opening	2.2	kV_{RMS}
U_{PDE}	(AQL 1/S4)	Partial discharge voltage (extinction)	1500	V_{RMS}
$U_{PD(rms)} \cdot 1.875$		*acc. table 24	2813	V_{RMS}

Type Test

Preconditioning acc. VAC M3236 (Pin 1,3,5 to primary opening)

$\hat{U}_W$	M3064	HV transient test (1.2µs / 50µs, 5 pulses ➔ polarity +, 5 pulses ➔ polarity -)	12	kV
U_P	M3014	Test voltage (5s)	4.4	kV_{RMS}
U_{PDE}	M3024	Partial discharge voltage (extinction)	1500	V_{RMS}
$U_{PD(rms)} \cdot 1.875$		*acc. table 24	2813	V_{RMS}

*** IEC61800-5-1:2007**

Applicable documents and standards

Constructed, manufactured and tested in accordance with IEC61800-5-1:2007.
Further standards: UL 508; file E317483, category NMTR2 / NMTR8

Explanation of the terms used in the datasheet

I_{SN}: Nominal secondary current (secondary current value at I_{PN})

$X_{total}(I_{PN})$: The sum of all possible errors over the temperature range by measuring a current I_{PN}:

$$X_{total} = 100 \cdot \left| \frac{I_S(I_{PN})}{K_N \cdot I_{PN}} - 1 \right|$$

X: Permissible measurement error in the final inspection at RT. I_{SB} is the DC output current for a DC primary current with the same value as the (positive) rated current I_{PN} (with I_O = 0)

$$X = 100 \cdot \left| \frac{I_{SB}}{I_{SN}} - 1 \right|$$

X_{Ti}: Temperature drift of the rated value orientated output term. I_{SN} (cf. Notes on F_i) in a specified temperature range: I_{SB} is the secondary current at temperature ϑ_{A1} or ϑ_{A2}

$$X_{Ti} = 100 \cdot \left| \frac{I_{SB}(\vartheta_{A2}) - I_{SB}(\vartheta_{A1})}{I_{SN}} \right|$$

ε_L: Linearity fault where I_P is any input DC and I_{Sx} the corresponding output term. (I_O = 0).

$$\varepsilon_L = 100 \cdot \left| \frac{I_P}{I_{PN}} - \frac{I_{Sx}}{I_{SN}} \right|$$

Offset, hysteresis and drift

I_{SO}: Offset current

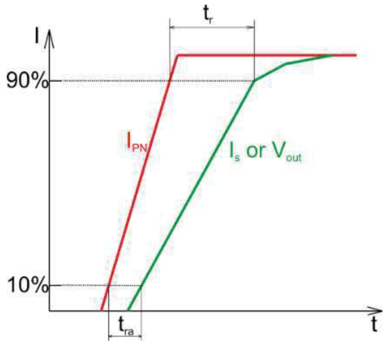
I_{SOH}: hysteresis offset at Ip=0A, meaning secondary current after overloading the sensor by a direct current of 3 * I_{PN} with R_M=100Ω

I_{Ot}: Long term drift of I_O after 100 temperature cycles in the range -40 to 85 °C.

Dynamic properties

$\Delta t(I_{P,max})$: delay time between a rectangular primary current and the output current I_S at I_P = 0.1 * I_{PN}

t_r: Response time, measured as a delay time between a rectangular primary current and the output current I_S at I_P = 0.9 * I_{PN}



Voltage ratings (according to IEC 61800-5-1:2007)

U_{PD} Rated discharge voltage (recurring peak voltage separated by the insulation)

U_{sys} System voltage: RMS value of rated voltage

U_{AC} Working voltage: RMS voltage which occurs by design in a circuit or across an insulation

U_{ACP} Working voltage recurring peak voltage acc. IEC 61800-5-1 which occurs by design in a circuit or across insulation.