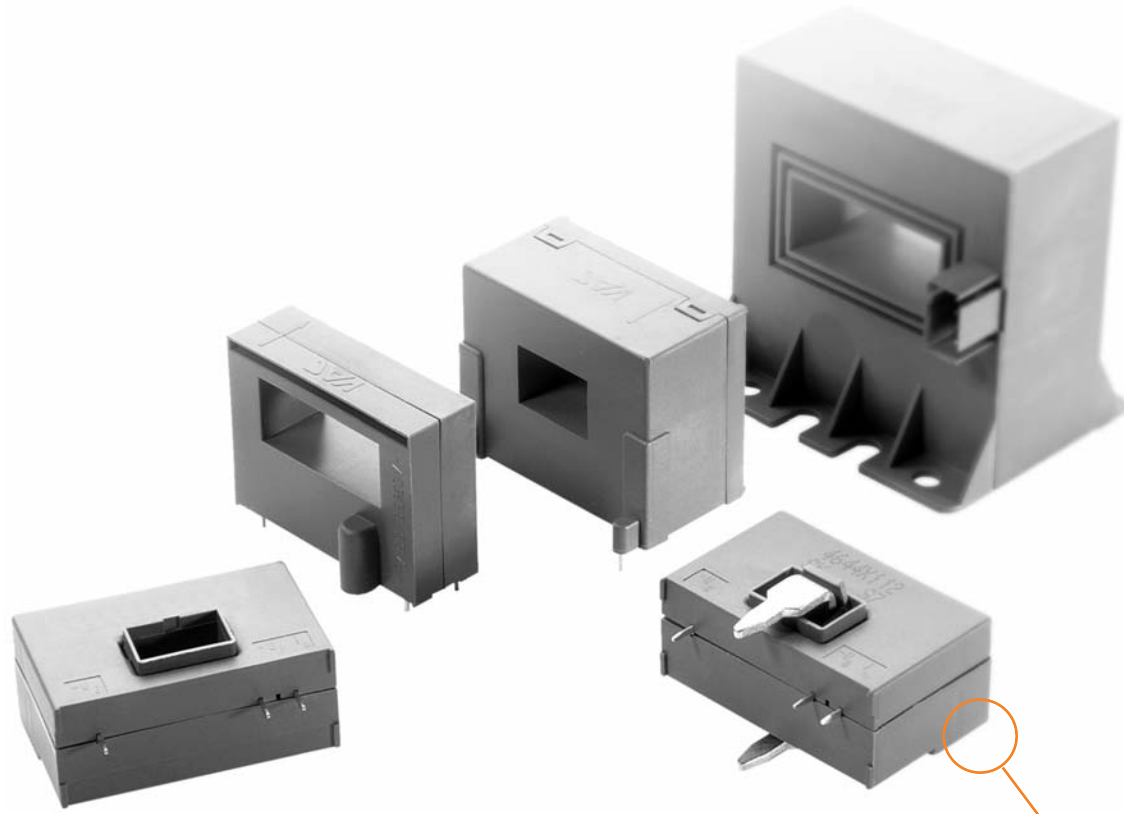
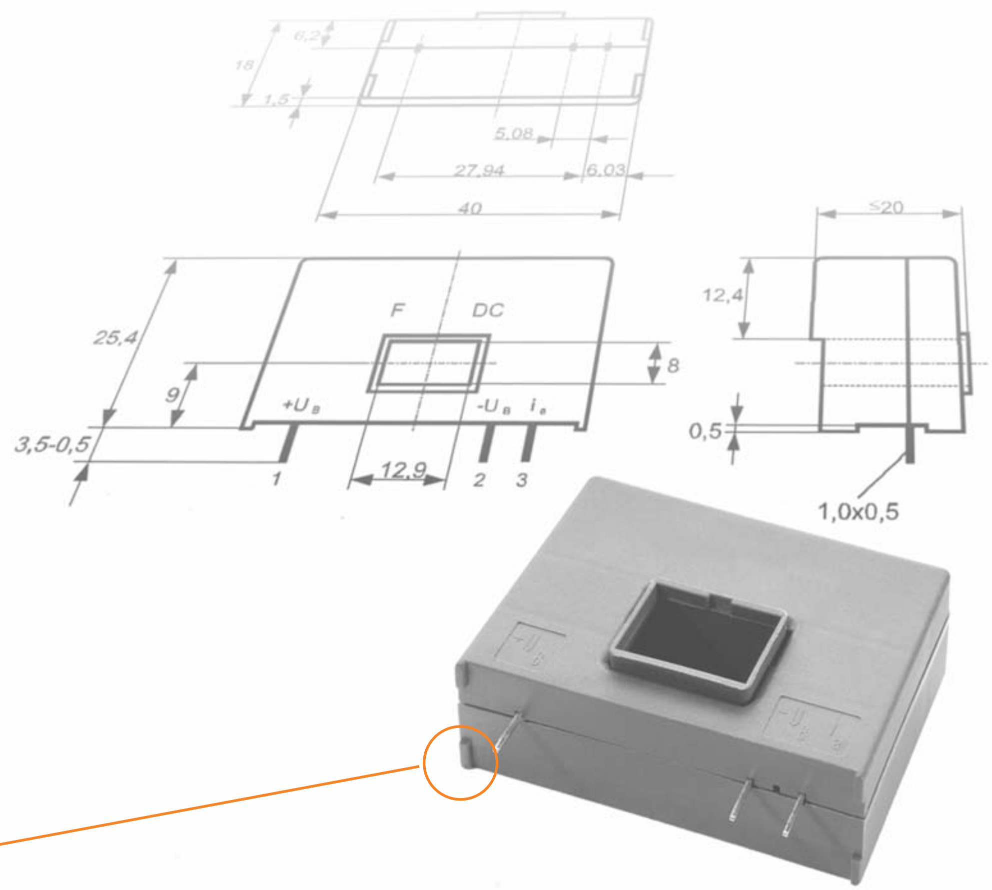


CURRENT SENSORS
WITH MAGNETIC FIELD PROBE
INDUSTRIAL APPLICATIONS

ADVANCED MATERIALS – THE KEY TO PROGRESS

VACUUMSCHMELZE

CURRENT SENSORS
WITH MAGNETIC FIELD PROBE
INDUSTRIAL APPLICATIONS



1. PREFACE

This brochure covers the standard current sensor range of VACUUMSCHMELZE GmbH & Co. KG (VAC) for the floating measurement of currents. Customized solutions are available on request.

VAC customers benefit from our comprehensive knowledge along the entire process chain. It starts with the material properties and goes over the dimensioning, the production technology and organization up to the world-wide procurement of purchased parts. VAC has decades of experience in the development, manufacturing and application of current sensors.

VAC current sensors apply in lowest up to high performance classes both in industry and in automotive applications:

- three phases drives, servo drives, generators
- power converters for DC drives
- battery operated applications
- uninterruptible power supplies
- switched mode power supplies
- welding inverters
- battery energy management

Our sensors are developed according to strictest international standards. Some types are UL approved. We also possess worldwide ISO 9001:2000 qualification.

2. TECHNOLOGIES

For current measurement, the market offers different technologies, like open- and closed loop hall effect sensors with galvanic separation, or shunts without galvanic separation.

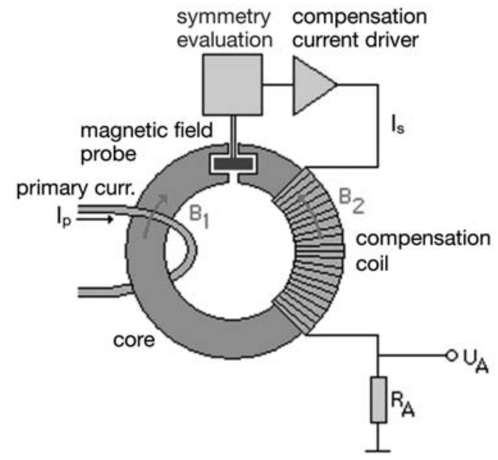
As the only manufacturer worldwide, VAC offers current sensors, which use a soft-magnetic probe in place of the hall generator as the magnetic field detector. In relation to conventional hall effect compensation sensors, our products offer some advantages:

- very low offset current with negligible long-term drift
- practically no temperature dependence of the offset current
- very small hysteresis of the offset current
- high usable temperature range (e.g. up to 110 °C in an IGBT module)
- the magnetic module can be separated from the electronics
- no electronics adjustment necessary
- attractively priced

3. FUNCTIONAL PRINCIPLE OF VAC CURRENT SENSORS

Two major advantages of the compensation current sensors are their principle-related high linearity and their excellent dynamic properties. The current I_p to be measured is magnetically coupled to the compensation current through a soft magnetic core. The magnetic flux of this core is measured by a magnetic field detector and controlled to zero by the electronics, generating a compensation current I_s in the compensation winding. This current is proportional to the primary current I_p.

When using a Hall generator as the magnetic field detector, which is the common method, an offset voltage and the associated drift occurs. For this reason VAC has developed a sensor using a low-drift soft magnetic metallic field detector. This has made it possible to reduce the offset current and its drift considerably. A smoother run of inverter-controlled motors even at low torque operation is the result. This preserves the bearings, prolongs the service life and leads to higher accuracy, especially in machine tools.



The type range of the VAC sensors offers a suitable solution for every current range and performance class.

The current sensors presented here are designed for the use in appliances and systems in stationary operation. In the case of traction – or automotive – applications please contact us.

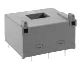
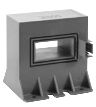
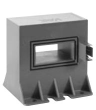
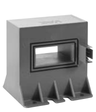
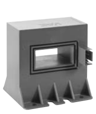
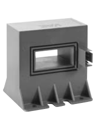
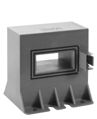
Class	Power [kW]	$I_{N, rms}$ [A]	I_{Npi} [A]
Micro	≤ 4	≤ 12	≤ 30 ≤ 42
Low-End	> 4 . . . ≤ 40	> 12 . . . ≤ 105	> 30 . . . ≤ 260 > 42 . . . ≤ 370
Midrange	> 40 . . . ≤ 200	> 105 . . . ≤ 430	> 260 . . . ≤ 1.075 > 370 . . . ≤ 1.505
High End	> 200 . . . ≤ 600	> 430 . . . ≤ 1.080	> 1.075 . . . ≤ 2.700 > 1.505 . . . ≤ 3.780
Mega	> 600	> 1.080 . . . ≤ 1.600	> 2.700 . . . ≤ 4.000 > 3.780 . . . ≤ 5.600

4. TYPE RANGE

4.1 ACTIVE SCURRENT SENSORS (with integrated electronics)

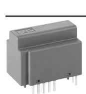
Partnumber Type T60404-N ...		$I_{PN, rms}$ [A]	$I_{P, max}$ [A]	T_A [°C]	V_C [V]	K_N	f [kHz]	X @I_{PN}, T_A= 25°C [%]	Primary connection: Pins	Primary connection: Centre hole for cable or bus bar	Secondary connection: Pins	Secondary connection: Connector	Integrated electronics	Potted	Incapsulated	Screw-on mounting	Drawing
	4644-X300	1-5-8-12-25 1-5-8-12-30 1-5-8-12-50	10-17-25-50 10-17-25-64 10-17-25-64	–40 ... +85 –40 ... +70 –40 ... +50	±15 V	(1...5):1000	DC...200	0,5	•		•		•		•		7
	4644-X400	7,5-15-30 7,5-15-40 7,5-15-54	23-46-92 23-46-92 23-46-92	–40 ... +85 –40 ... +70 –40 ... +50	±15 V	(1...4):2000	DC...100	0,5	•		•		•		•		8
	4644-X101	50 100 120	150 150 150	–40 ... +85 –40 ... +70 –40 ... +55	±15 V	1 : 2000	DC...100	0,5		•	•		•		•		3
	4644-X100	50 50	70 92	–40 ... +85 –40 ... +70	±15 V	1 : 1000	DC...100	0,5		•	•		•		•		3
	4644-X111	50 100 120	150 150 150	–40 ... +85 –40 ... +70 –40 ... +55	±15 V	1 : 2000	DC...100	0,5	•		•		•		•		4
	4644-X112	50 50	70 92	–40 ... +85 –40 ... +70	±15 V	1 : 1000	DC...100	0,5	•		•		•		•		4
	4644-X201	125 200 200 250	350 300 350 350	–40 ... +85 –40 ... +85 –40 ... +70 –40 ... +55	±15 V	1 : 2000	DC...100	0,5		•	•		•		•		5
	4644-X200	125 125	200 175	–40 ... +70 –40 ... +85	±15 V	1 : 1000	DC...100	0,5		•	•		•		•		5
	4644-X202	125 125	200 175	–40 ... +70 –40 ... +85	±15 V	1 : 1000	DC...100	0,5		•	•		•		•		5

(shaded) = preferred type

Partnumber Type T60404-N ...		$I_{PN, rms}$ [A]	$I_{P, max}$ [A]	T_A [°C]	V_C [V]	K_N	f [kHz]	X @I_{PN}, T_A= 25°C [%]	Primary connection		Secondary connection		Integrated electronics	Potted	Incapsulated	Screw-on mounting	Drawing
									Pins	Centre hole for cable or bus bar	Pins	Connector					
	4644-X271	125	350	–40 ... +85	±15 V	1 : 2000	DC...100	0,5		•	•		•		•		6
		200	300	–40 ... +85													
		200	350	–40 ... +70													
		250	350	–40 ... +55													
	4644-X052	250	700	–40 ... +105	±15 V	1 : 2000	DC...50	0,5		•		• Molex	•		•	•	2
		400	700	–40 ... +85													
		500	700	–40 ... +70													
		200	560	–40 ... +105	±12 V												
		320	560	–40 ... +85													
		400	560	–40 ... +70													
	4644-X053	250	700	–40 ... +105	±15 V	1 : 2000	DC...50	0,5		•		• Molex	•	•		•	2
		400	700	–40 ... +85													
		500	700	–40 ... +70													
		200	560	–40 ... +105	±12 V												
		320	560	–40 ... +85													
		400	560	–40 ... +70													
	4644-X020	200	400	–40 ... +70	±15 V	1 : 2000	DC...50	0,5		•	•		•		•		1
	4644-X021	200	300	–40 ... +85	±15 V	1 : 4000	DC...30	0,5		•	•		•		•		1
	4644-X031	200	300	–40 ... +85	±15 V	1 : 4000	DC...30	0,5		•		• Comatel	•		•	•	2
	4644-X030	200	400	–40 ... +70	±15 V	1 : 2000	DC...50	0,5		•		• Comatel	•		•	•	2
	4644-X050	400	425	–40 ... +85	±15 V	1 : 5000	DC...50	0,5		•		• Molex	•		•	•	2
		320	340	–40 ... +85	±12 V												
	4644-X040	400	625	–40 ... +85	±15 V	1 : 5000	DC...50	0,5		•		• Comatel	•		•	•	2
		320	500	–40 ... +85	±12 V												
	4644-X060	400	625	–40 ... +85	±15 V	1 : 5000	DC...50	0,5		•		• Molex	•		•	•	2
		320	500	–40 ... +85	±12 V												
	4644-X055	250	700	–40 ... +105	±15 V	1 : 2000	DC...50	0,5		•		• Molex	•	•		•	2
		400	700	–40 ... +85													
		500	700	–40 ... +70													
		200	560	–40 ... +105	±12 V												
		320	560	–40 ... +85													
		400	560	–40 ... +70													
	4644-X056	500	1000	–40 ... +75	± 24 V	1 : 3000	DC...50	0,5		•		• Molex	•	•		•	2
	4644-X054	250	1250	–40 ... +105	±15 V	1 : 3000	DC...50	0,5		•		• Molex	•	•		•	2
		400	1250	–40 ... +85													
		700	1250	–40 ... +70													
		200	1000	–40 ... +105	±12 V												
		320	1000	–40 ... +85													
		400	1000	–40 ... +70													

4.2 PASSIVE CURRENT SENSORS

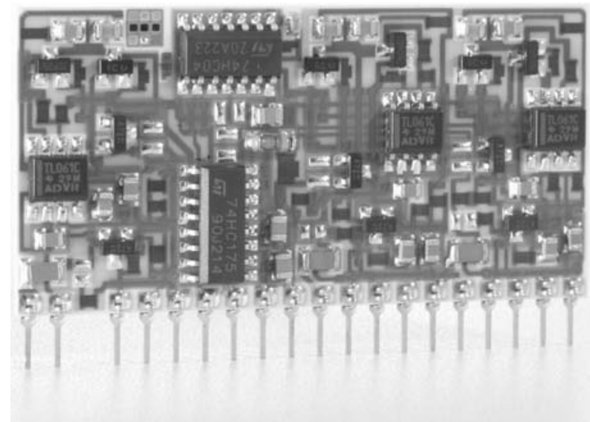
(with separated electronics)

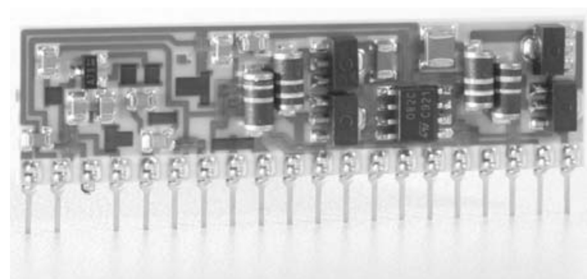
Partnumber Type T60404-M ...		$I_{PN, rms}$ [A]	$I_{P,max}$ [A]	T_A [°C]	V_C [V]	K_N	f [kHz]	X @I_{PN}, T_A= 25°C [%]	Primary connection: Pins	Primary connection: Centre hole for cable or bus bar	Secondary connection: Pins	Secondary connection: Connector	Electronics: Integrated	Electronics: Separated	Electronics: Number: One phase	Electronics: Number: Two phases	Electronics: Number: Three phases	Potted	Incapsulated	Screw-on mounting	Crawing
	4645-X010	3-6-10-20 6-12-20-40	27 60	–40 ... +85	+5 V ±15 V	(1...6):1000	DC...100	0,5	•		•			•	1,4	2	3		•		9
	4645-X011	6-12-20-40	55	–40 ... +85	±15 V	(1...6):3000	DC...100	0,5	•		•			•	1	2	3		•		9
	4645-X012	6-12-20-40	60	–40 ... +85	±15 V	(1...6):1000	DC...100	0,5	•		•			•	1	2	3		•		9
	4645-X211	10-16-25-50	90	–40 ... +85	+5 V	(1...5):1000	DC...100	0,5	•		•			•	4				•		11
	4645-X050	100	160	–40 ... +85	±15 V	1 : 1000	DC...100	0,5		•	•			•	1	2	3		•	•	10
	4645-X051	100	142	–40 ... +85	±15 V	1 : 2000	DC...100	0,5		•	•			•	1	2	3		•	•	10
	4645-X070	200	400	–40 ... +85	±15 V	1 : 2000	DC...50	0,5		•	•			•	1	2	3		•	•	1
	4645-X072	200	400	–40 ... +85	±15 V	1 : 3000	DC...30	0,5		•	•			•	1	2	3		•	•	1

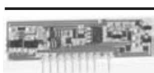
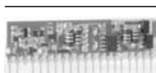
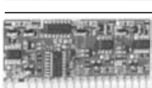
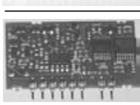
= preferred type

4.3 ELECTRONICS

(for passive current sensors)

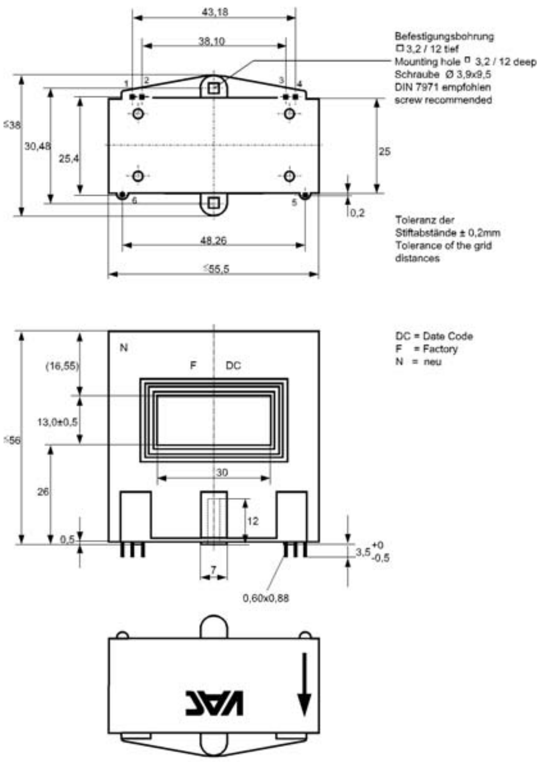


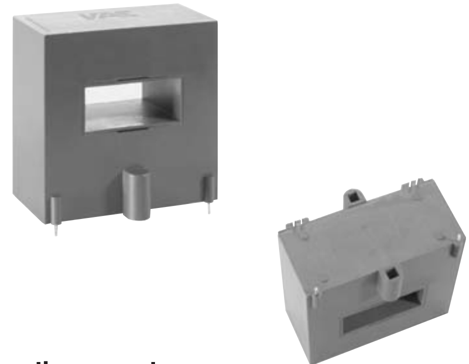


Partnumber Type T60404-Q ...		connectable magnetic modules	I_C [mA]	V_C [V]	P_{VE0} [mW]	$P_{VE, max}$ [W]	Number
	5790-X013	1	14	±15 V ±5 %	420	1	1
	5790-X023	2	19	±15 V ±5 %	570	1	2
	5790-X101	3	50	±15 V ±5 %	750	2	3
	5790-X052	1	35	+5 V ±5 %	175		4

4.4 DIMENSIONAL DIAGRAMS OF SENSORS

Drawing No. 1





active current sensors:

T60404-N4644-X020

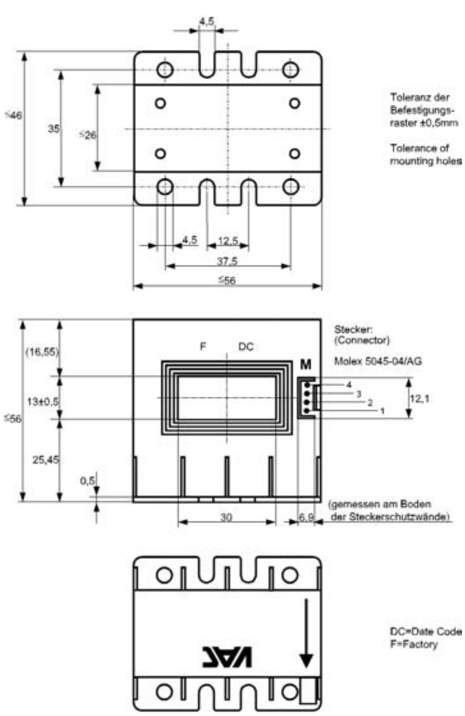
T60404-N4644-X021

passive current sensors:

T60404-M4645-X070

T60404-M4645-X072

Drawing No. 2



potted version

active current sensors:

T60404-N4644-X053

T60404-N4644-X054

T60404-N4644-X055

T60404-N4644-X056

incapsulated version

active current sensors:

T60404-N4644-X052

T60404-N4644-X030

T60404-N4644-X031

T60404-N4644-X040

T60404-N4644-X050

T60404-N4644-X051

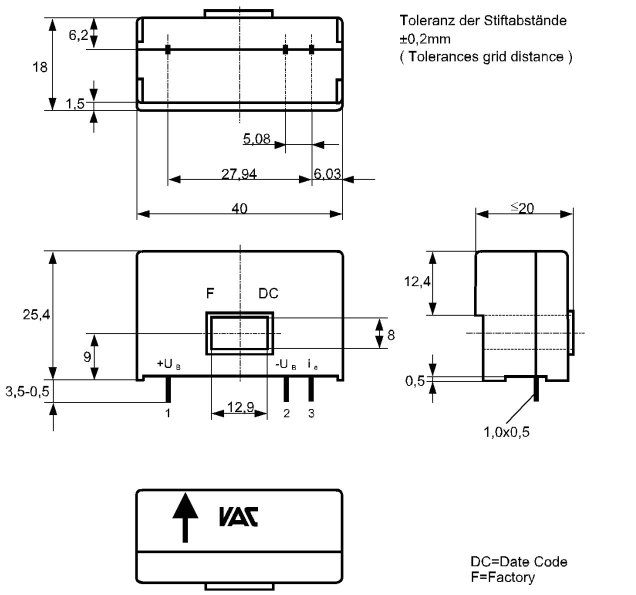
T60404-N4644-X060

passive current sensors:

not available in this casing

4.4 DIMENSIONAL DIAGRAMS OF SENSORS

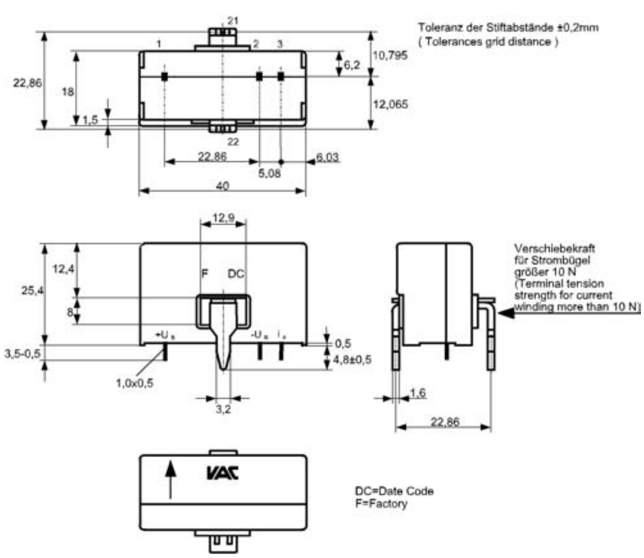
Drawing No. 3



active current sensors:
T60404-N4644-X101
T60404-N4644-X100

passive current sensors:
not available in this casing

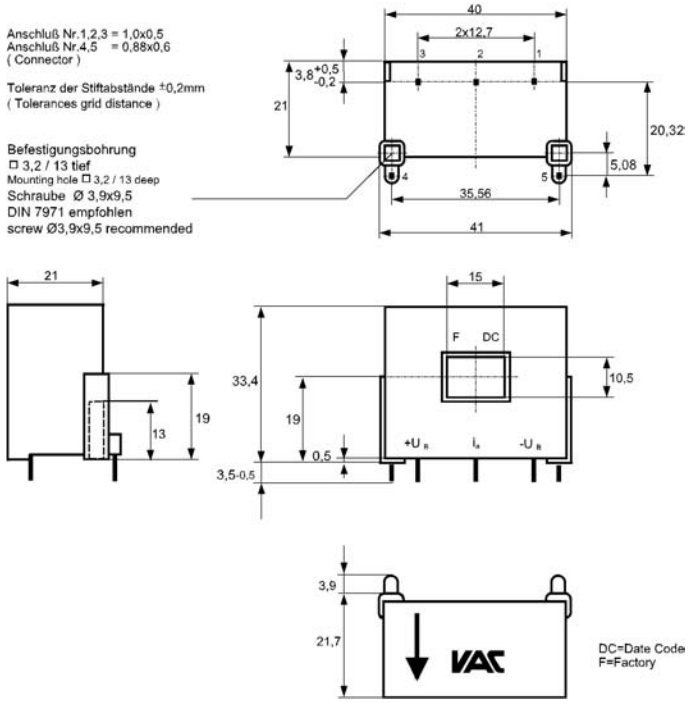
Drawing No. 4



active current sensors:
T60404-N4644-X111
T60404-N4644-X112

passive current sensors:
not available in this casing

Drawing No. 5



active current sensors:

T60404-N4644-X200

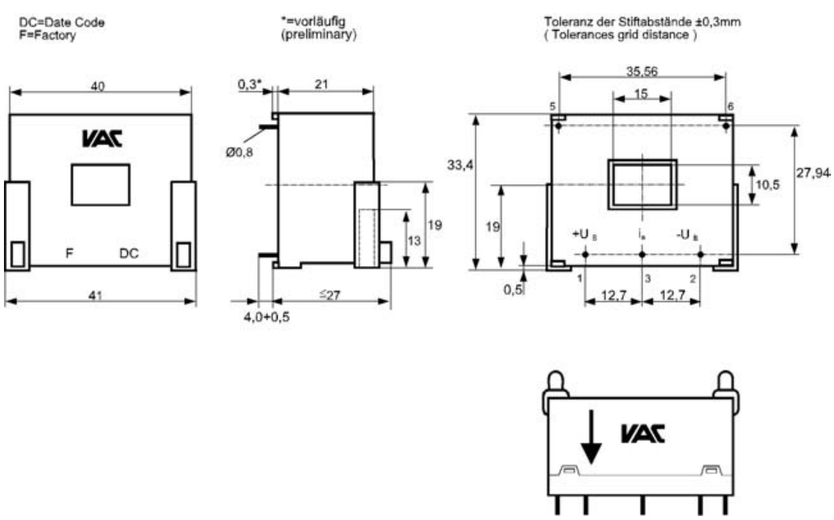
T60404-N4644-X201

T60404-N4644-X202

passive current sensors:

not available in this casing

Drawing No. 6



active current sensors:

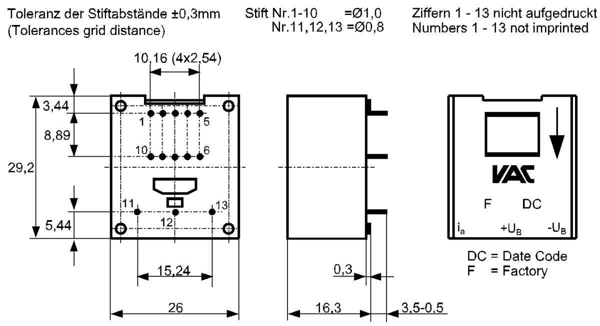
T60404-N4644-X271

passive current sensors:

not available in this casing

4.4 DIMENSIONAL DIAGRAMS OF SENSORS

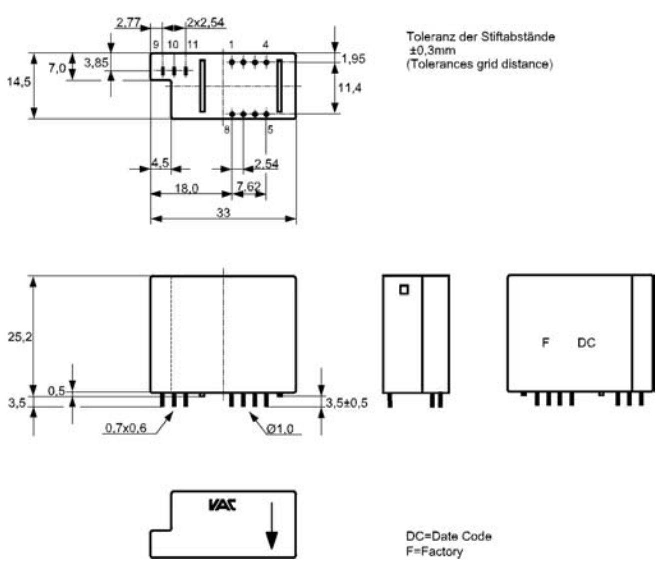
Drawing No. 7



active current sensors:
T60404-N4644-X300

passive current sensors:
not available in this casing

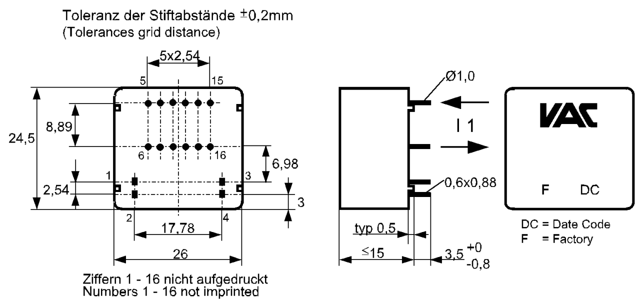
Drawing No. 8



active current sensors:
T60404-N4644-X400

passive current sensors:
not available in this casing

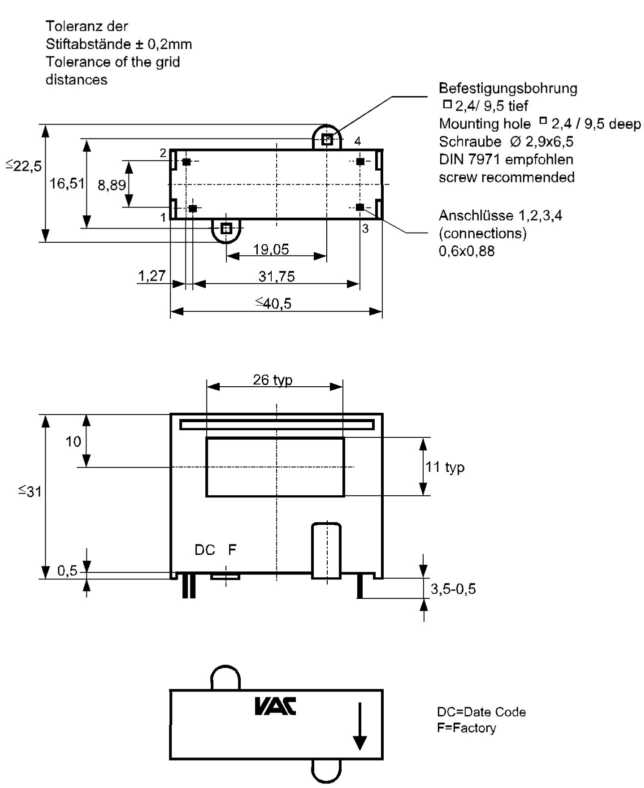
Drawing No. 9



active current sensors:
not available in this casing

passive current sensors:
T60404-N4645-X010
T60404-N4645-X011
T60404-N4645-X012

Drawing No. 10

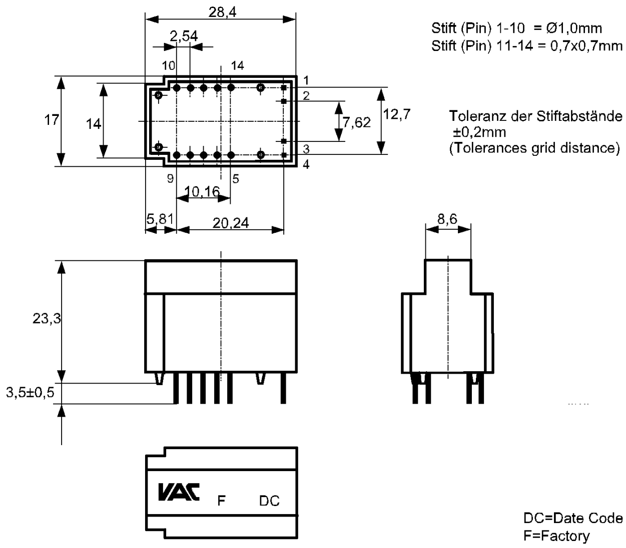


active current sensors:
not available in this casing

passive current sensors:
T60404-N4645-X050
T60404-N4645-X051

4.4 DIMENSIONAL DIAGRAMS OF SENSORS

Drawing No. 11



active current sensors:
not available in this casing

passive current sensors:
T60404-N4645-X211

5. ABBREVIATIONS AND TERMINOLOGY

Unit		Description
C_k	pF	Maximum possible coupling capacity (primary - secondary)
$\Delta I_0/\Delta V_C$	mA/V	Supply voltage rejection ratio
$\Delta t\ (I_{P,max})$	µs	Delay time at di/dt = 100 A/ms
$\Delta V_0/\Delta T_A$	µV/°C	Offset voltage drift @TA=-40…+85°C
$\Delta V_{out}/\Delta T_A$	V/µs	Slew rate output voltage
$\Delta\Phi$(S1-S2)	nVs	Magnetic flux sensor
ϵ_L	%	Linearity
f	kHz	Frequency range
I_0	mA	Offset current @ I_P=0, T_A=25°C)
I_{0ges}	A	Offset current (including I_0, I_{0t}, I_{0T})
I_{0H}	mA	Hysteresis current @ I_P=0 caused by primary current 3 x I_{PN}
I_{0t}	mA	Offset current drift
I_{0T}	mA	Offset current temperature drift @ T_A=-40..+85°C
I_C	mA	Supply current
I_{comp}	mA	Compensation current
i_{oss}	mA	Offset ripple
$I_{P,max}$	A	maximum measuring range @ $R_M = 100\ \Omega$
I_{PN}	A	Primary rated current, RMS
$I_{S,max}$	mA	Maximum output current
I_{SN}	A	Output rated current, RMS
K_N		Transformation ratio
m	g	Mass
P_{VE0}	mW	No load power losses
$P_{VE,max}$	W	Maximum permissible power loss @T_A=70°C
R(S1-S2)	Ω	Winding resistance magnetic probe coil
R_M	Ω	Load resistance
R_P	Ω	Primary coil resistance per turn @ T_A=25°C
R_S	Ω	Secondary coil resistance @T_A=85°C
R_S(K1-K2)	Ω	Winding resistance compensation winding

Unit		Description
T_A	°C	Ambiente temperature
t_r	µs	Response time
T_S	°C	Storage temperature range
V_0	V	Offset voltage vs. reference voltage
V_b	V	Working voltage
V_c	V	Supply voltage
V_{Ctot}	V	Maximum supply voltage (without function)
V_d	kV	Test voltage, RMS, 1s
V_e	kV	Partial discharge voltage
V_{K1}	V	Voltage at K1
V_{out}	V	Output voltage
V_{Ref}	V	Reference voltage
X	%	Measuring accuracy @ I_{PN}, T_A = 25°C
X_{Ti}	%	Temperatur drift of X @ T_A=-40 ..+85°C

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