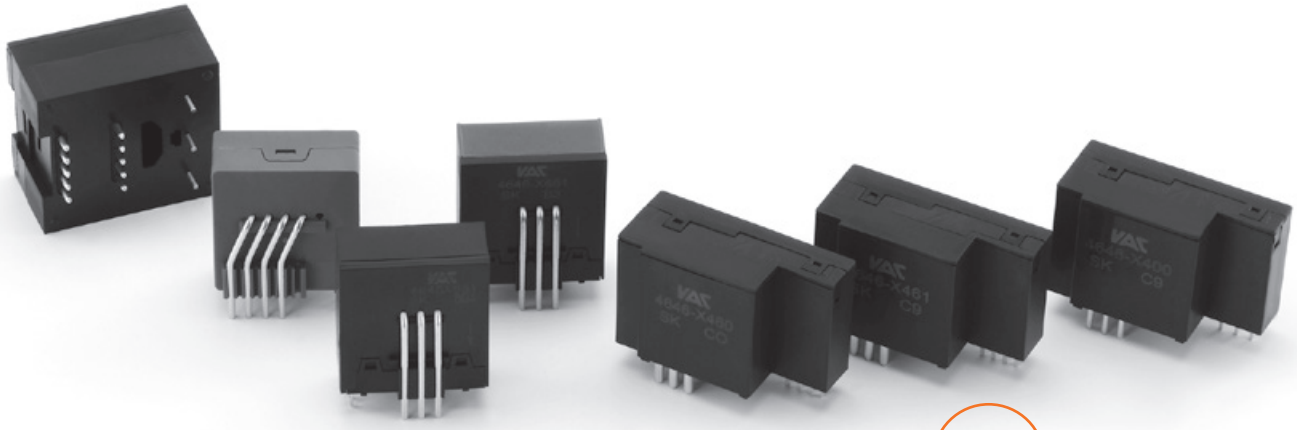
ACTIVE
CURRENT SENSORS
FOR MAXIMUM ACCURACY



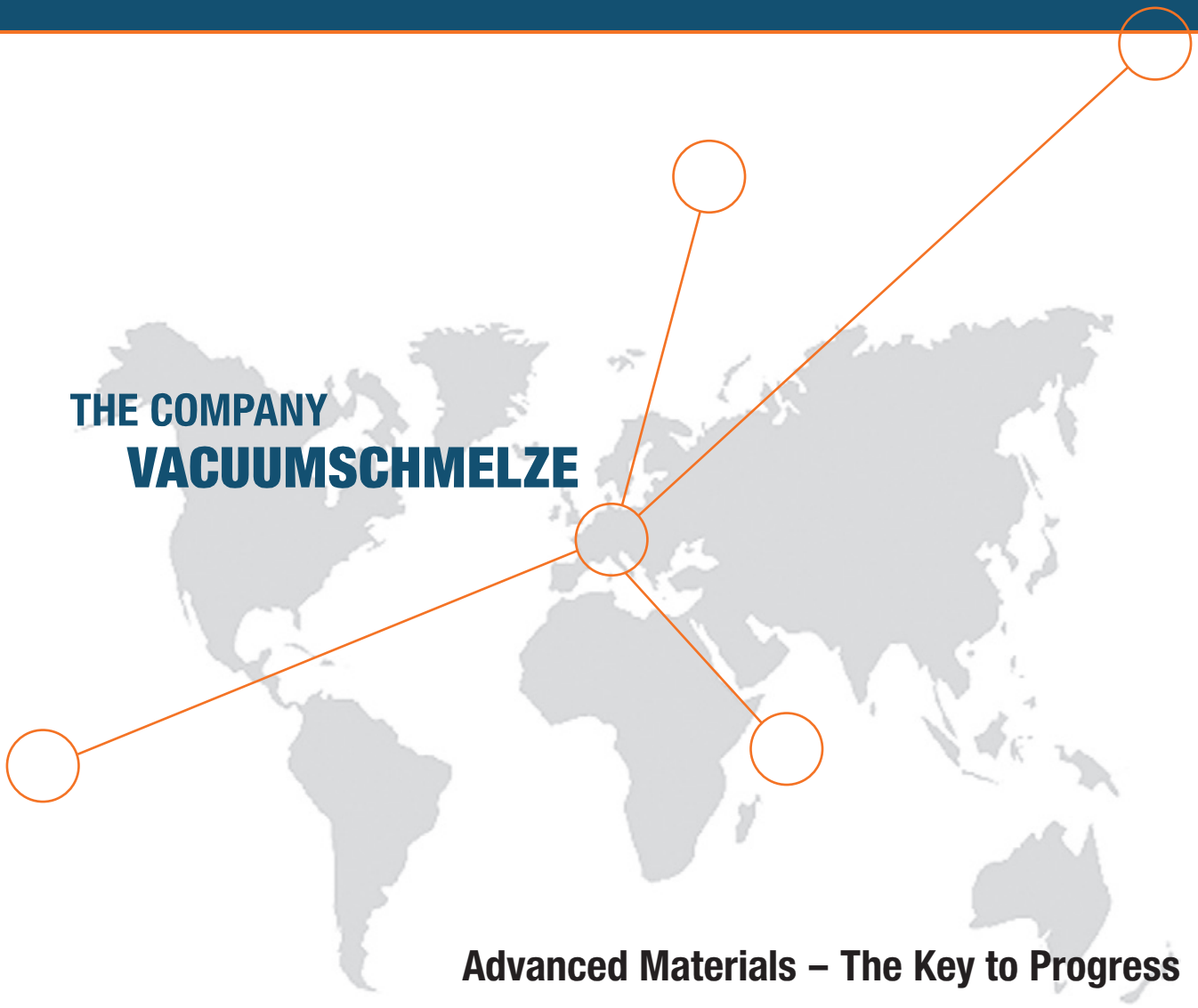
ADVANCED MATERIALS – THE KEY TO PROGRESS

VACUUMSCHMELZE

THE COMPANY
VACUUMSCHMELZE

We are a global company with our headquarters in Hanau, Germany. We currently have over 4000 employees who are spread over production and sales locations in more than 40 countries on every continent to generate annual sales of approximately EUR 490 million.

Contents



THE COMPANY VACUUMSCHMELZE

Advanced Materials – The Key to Progress

VACUUMSCHMELZE GmbH & Co. KG is one of world's leading producers of special metallic materials and related products. Our wide range of high quality semi-finished products, parts, components and systems are used in virtually every field of electrical and electronic engineering. This makes us one of the few global companies to offer its customers the complete range of magnetic technology products from a single source – from magnetically soft products to the most powerful permanent magnets in the world.

In all our activities, we benefit from our highly developed material expertise and our decades of experience in magnetic technology. As early as 1923, we became the first company to introduce alloy smelting in a vacuum on an industrial scale and it was from this process that the name VACUUMSCHMELZE was derived.

One of our great strengths is our versatility. All of the world's key industries rely on products and expertise from VACUUMSCHMELZE, with our principal customers active in drive and installation technology, medical technology, renewable energy, automation systems, process and control engineering, measurement technology, as well as the very important automotive and aerospace industries. VAC's dedicated solutions are developed in close cooperation with customers and reflect the highest levels of material and application expertise combined with the latest production technology.

ACTIVE CURRENT SENSORS FOR MAXIMUM ACCURACY

VAC CURRENT SENSOR SERIES

VAC offers four current sensor series für PCB mounting in which electronics and primary conductors are integrated.

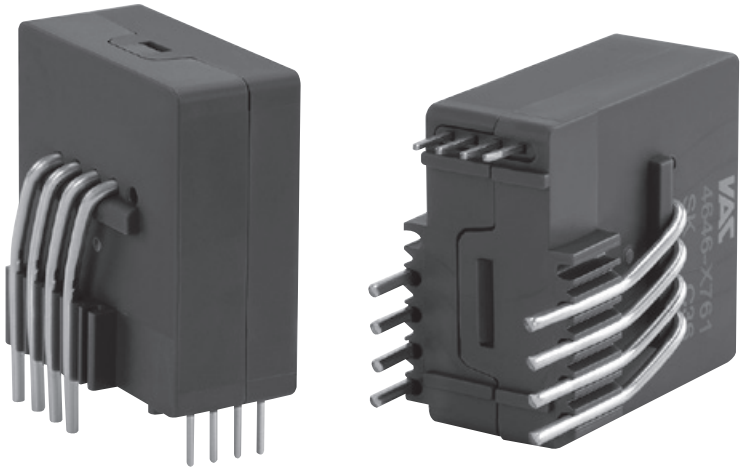
The VAC principle of the closed-loop sensor with magnetic probe as a zero field detector is distinguished by maximum precision of the current detection. The electronics of the new VAC current sensors are concentrated almost entirely in a new IC, which has been developed by VAC in conjunction with a leading semiconductor manufacturer.

Though providing very compact design all types offer the detection of high maximum and continuous currents. The new VAC sensors can be used 1:1 in many customer applications without adaptations.

TYPICAL APPLICATIONS

- Variable speed drives
- Uninterruptible power supplies
- Welding inverters
- Switched mode power supplies
- Photovoltaics

- closed-loop sensor with magnetic probe developed by VAC
- four standard series for rated currents of 6 A to 100 A and peak currents up to + 200 A in compact designs
- types for + 5 Volt power supply with voltage output. Optional internal or external reference voltage
- types for ± 12 ... 15 Volt power supply with current output
- very good measuring accuracy, minimum DC offset with very low hysteresis
- negligible output noise or periodic signal at zero input
- very low temperature dependence and long-term drift of the output variable
- low rise time, wide frequency range
- low-cost constructions
- industry standard dimensions and pinning



TYPE SERIES OF VAC CURRENT SENSORS

Item no. Type T60404-N…		Rated current $I_{PN, rms}$@K_N = 1 : N [A]	Max. measuring range $I_{Pmax.}$ @ V_C = + 5 V or V_C = ± 15 V [A]	Turns ratio K_N	Output variable	V_{ref}-input/output[2]	Ambient temperature range T_{amb} [° C] -40 to	Supply voltage V_C [V]	Creepage/clearance [mm]	System/working voltage acc. to EN 61800-5-1 (reinforced insul.; insul. mat. group 1; PD 2; OV 3) [V]	Frequency range f [kHz] DC to	Accuracy X @ I_{PN}; T_{amb} = 25 °C [%]	Mechanical outline
	4646-X653[3]	6 3 2	±20 ±10 ±7	1:2000 2:2000 3:2000	V[5]		+85	+5	7/7	300/650	200	0.7	1
	4646-X652[3]	15 7.5 5	±51 ±25 ±17	1:2000 2:2000 3:2000	V[5]		+85	+5	7/7	300/650	200	0.7	1
	4646-X651[3]	25 12 8	±85 ±42 ±28	1:2000 2:2000 3:2000	V[5]		+85	+5	7/7	300/650	200	0.7	1
	4646-X654[3]	50 12 8	±150 ±75 ±50	1:1400 2:1400 3:1400	V[5]		+85	+5	7/7	300/650	200	0.7	1
	4646-X663[2]	6 3 2	±20 ±10 ±7	1:2000 2:2000 3:2000	V[5]	yes	+85	+5	7/7	300/650	200	0.7	2
	4646-X662[1,2]	15 7.5 5	±51 ±25 ±17	1:2000 2:2000 3:2000	V[5]	yes	+85	+5	7/7	300/650	200	0.7	2
	4646-X661[1,2]	25 12 8	±85 ±42 ±28	1:2000 2:2000 3:2000	V[5]	yes	+85	+5	7/7	300/650	200	0.7	2
	4646-X664[2]	50 12 8	±150 ±75 ±50	1:1400 2:1400 3:1400	V[5]	yes	+85	+5	7/7	300/650	200	0.7	2
	4646-X763	6 3 1.5	±20 ±10 ±5	1:2000 2:2000 4:2000	V[5]	yes	+85	+5	9.6/10.6	600/1060	200	0.7	3
	4646-X762	15 7.5 3.75	±51 ±25.5 ±12.5	1:2000 2:2000 4:2000	V[5]	yes	+85	+5	9.6/10.6	600/1060	200	0.7	3
	4646-X761	25 12 6	±85 ±42 ±21	1:2000 2:2000 4:2000	V[5]	yes	+85	+5	9.6/10.6	600/1060	200	0.7	3
	4646-X764	50 12 6	±150 ±75 ±37.5	1:1400 2:1400 4:1400	V[5]	yes	+85	+5	9.6/10.6	600/1060	200	0.7	3

Item no. Type T60404-N…		**Rated current** $I_{PN,rms}@K_N = 1:N$ [A]	**Max. measuring range** $I_{Pmax.}$ @ $V_C = +5$ V or $V_C = \pm 15$ V [A]	**Turns ratio** K_N	**Output variable**	**V_{ref}-input/output**[2]	**Ambient temperature range** T_{amb} [° C] -40 to	**Supply voltage** V_C [V]	**Creepage/clearance** [mm]	**System/working voltage acc. to EN 61800-5-1** (reinforced insul.; insul. mat. group 1; PD 2; OV 3) [V]	**Frequency range** f [kHz] DC to	**Accuracy** X @ I_{PN}; $T_{amb} = 25$ °C [%]	**Mechanical outline**
	4646-X460[2]	50 25 17	±150 ±75 ±50	1:1400 2:1400 3:1400	V[5]	yes	+85	+5	10.2/10.2	600/1020	100	0.7	4
	4646-X461[2]	100 50 33	±200 ±100 ±66	1:1100 2:1100 3:1100	V[5]	yes	+85	+5	10.2/10.2	600/1020	100	0.7	4
	4646-X300	25 12 8 6 5	±85 ±43 ±28 ±21 ±17	1:1000 2:1000 3:1000 4:1000 5:1000	I		+85	+12 ... 15	10.2/10.2	600/1020	200	0.5	5
	4646-X400	25 10 8	±130 ±65 ±43	1:1000 2:1000 3:1000	I		+85	+12 ... 15	10.2/10.2	600/1020	200	0.5	6
	4646-X410	50 20 15	±128 ±64 ±43	1:1000 2:1000 3:1000	I		+85	+12 ... 15	10.2/10.2	600/1020	200	0.5	7
	4646-X412	100 35 25	±175 ±82 ±58	1:2000 2:2000 3:2000	I		+85	+12 ... 15	10.2/10.2	600/1020	200	0.5	7
	4646-X413	100 35 25	±208 ±104 ±69	1:1500 2:1500 3:1500	I		+85	+12 ... 15	10.2/10.2	600/1020	200	0.5	7

[1] Reflow-solderable versions (“Paste-to-Pin”) of these types are available. Please enquire.

[2] Reference voltage output 2.5 ± 0.005 V. Ri = 670 Ohm. Can be overwritten and therefore used as an input for an external reference. Voltage range 0 ... 4 V.

[3] Types without reference voltage input/output (V_{ref} – pin): For new developments we recommend the use of the types of 4646-X66x or 4646-X76x with reference voltage input/output to achieve higher measuring accuracy.

[4] The rated current for these types is only a reference value. They all can be used up to the maximum ambient temperature, loaded with the following rms values per primary turn: 17 A in parallel connection, 12 A in series connection. Within these limits, the sensor type can be selected according to the measuring range.

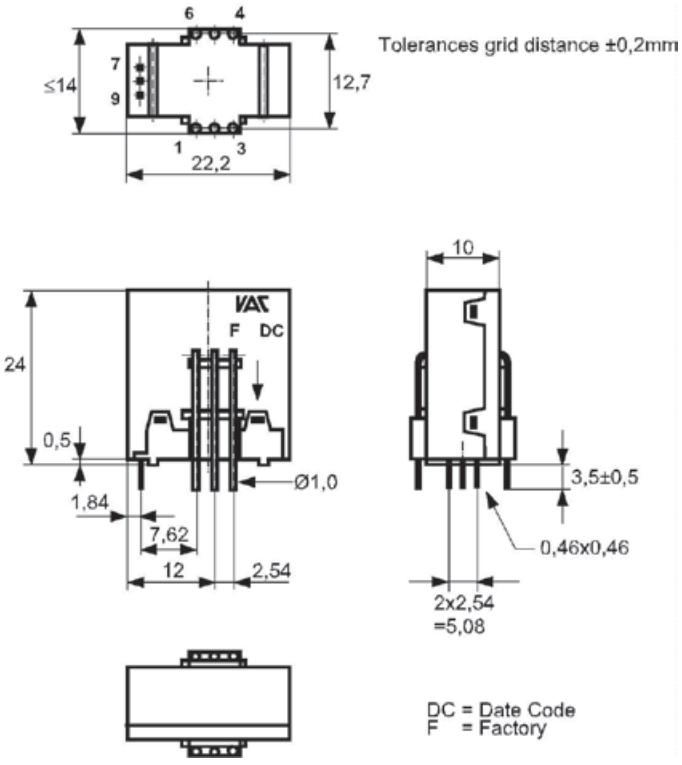
[5] $V_A = V_{ref} \pm (0.625 * I_P/I_{PN})$, resp. $V_A = 2.5\,V \pm (0.625 * I_P/I_{PN})$.

Examples, type 4646-X761: Primary current (peak) = 85 A. Output voltage range (peak) = 2.5 V ± (0.625 * 85 A/25 A) = 0.375 V ... 4.625 V

Primary current (RMS) = 20 A. Output voltage range (RMS) = 0.625 * 20 A/25 A = 0.5 V_{rms}

MECHANICAL OUTLINES

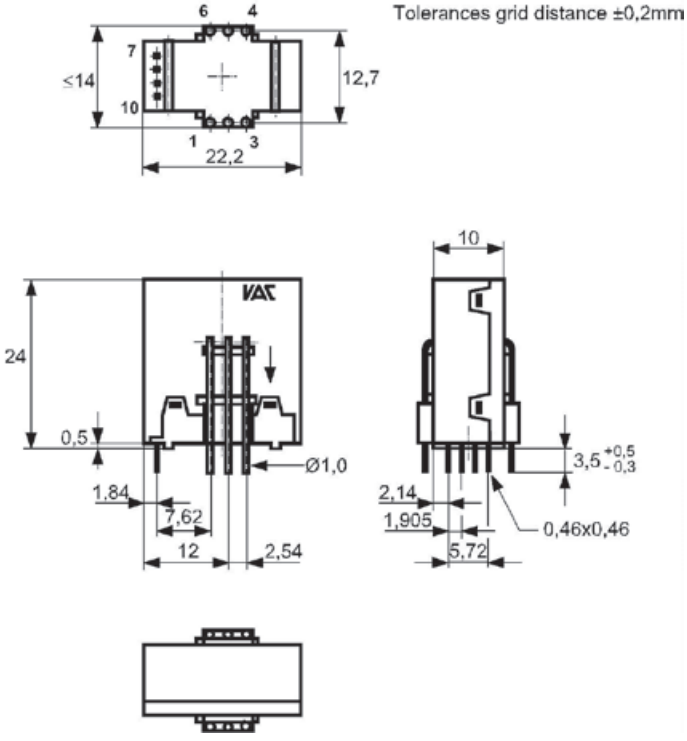
Drawing no. 1



Type

T60404-N4646-X651
T60404-N4646-X652
T60404-N4646-X653
T60404-N4646-X654

Drawing no. 2

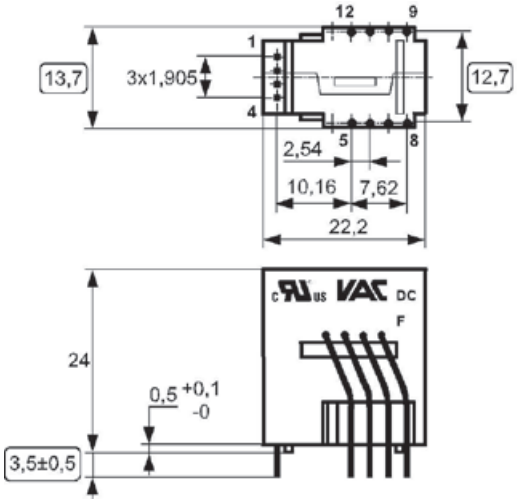


Type

T60404-N4646-X661
T60404-N4646-X662
T60404-N4646-X663
T60404-N4646-X664

Photos for illustration purposes only

Drawing no. 3



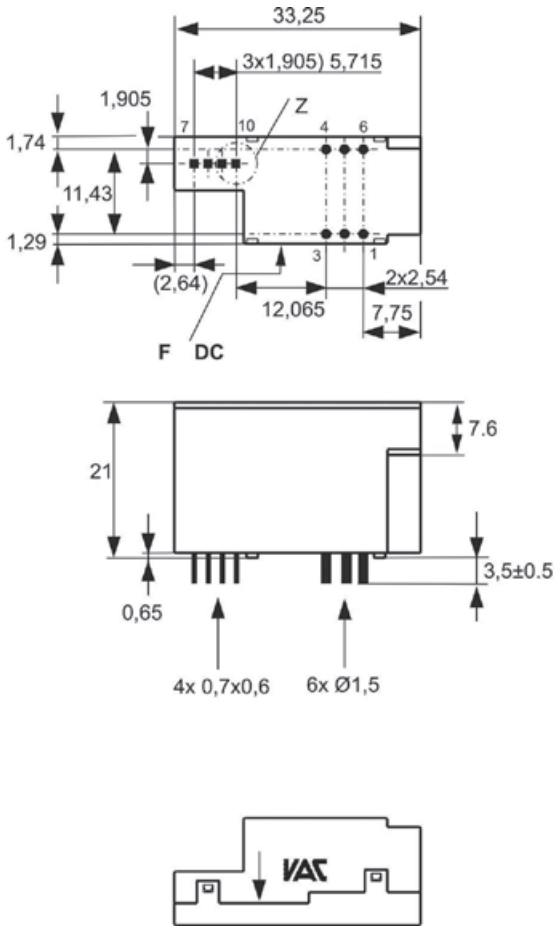
test dimension

Tolerances grid distance ±0,25mm

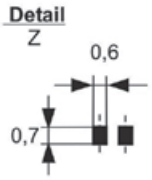
Type

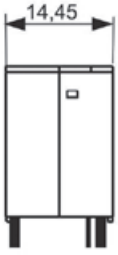
T60404-N4646-X761
T60404-N4646-X762
T60404-N4646-X763
T60404-N4646-X764

Drawing no. 4



Tolerances grid distance ±0,2mm





DC = Date Code
F= Factory

Type

T60404-N4646-X460
T60404-N4646-X461

Photos for illustration purposes only

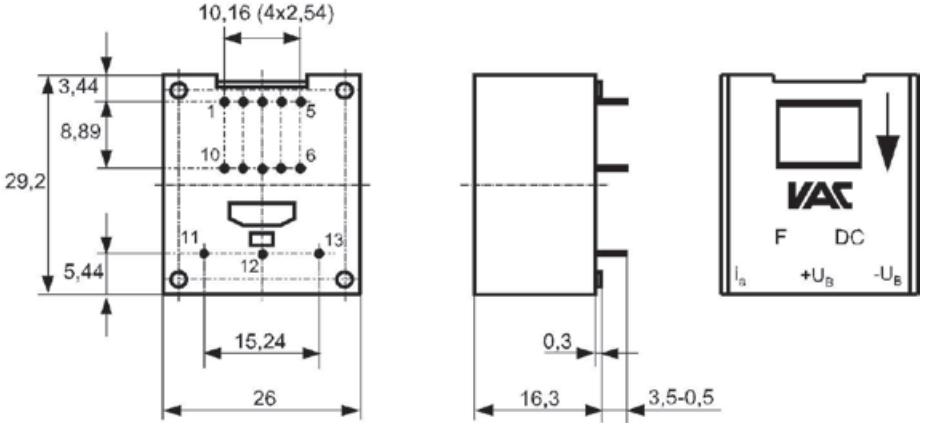
Drawing no. 5

Type
T60404-N4646-X300

Tolerances grid distance ±0,3

Numbers 1 - 13 not imprinted

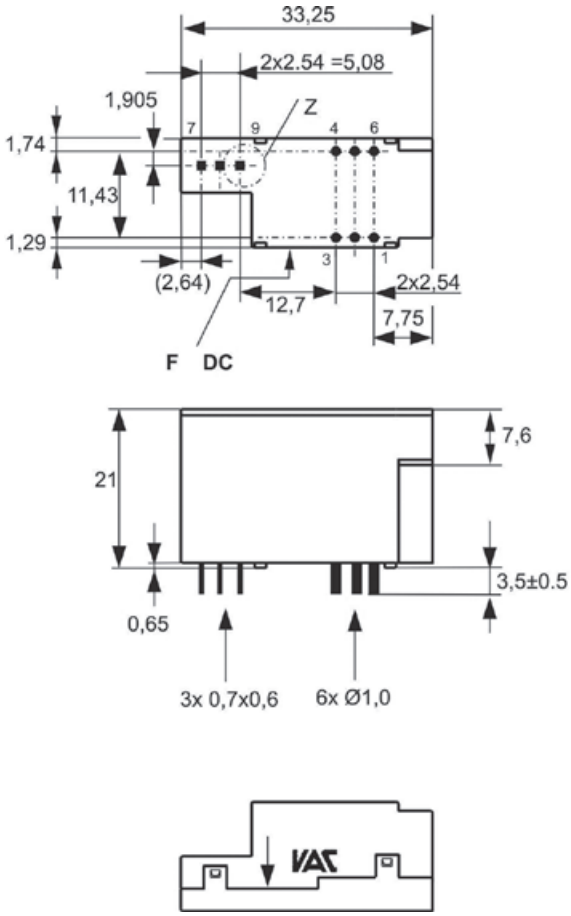
DC = Date Code
F = Factory

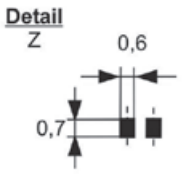


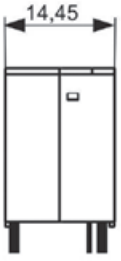
Drawing no. 6

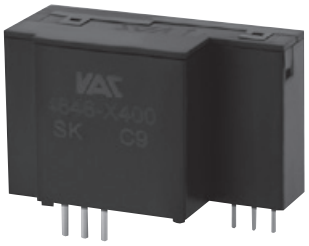
Type
T60404-N4646-X400

Tolerances grid distance ±0,2mm





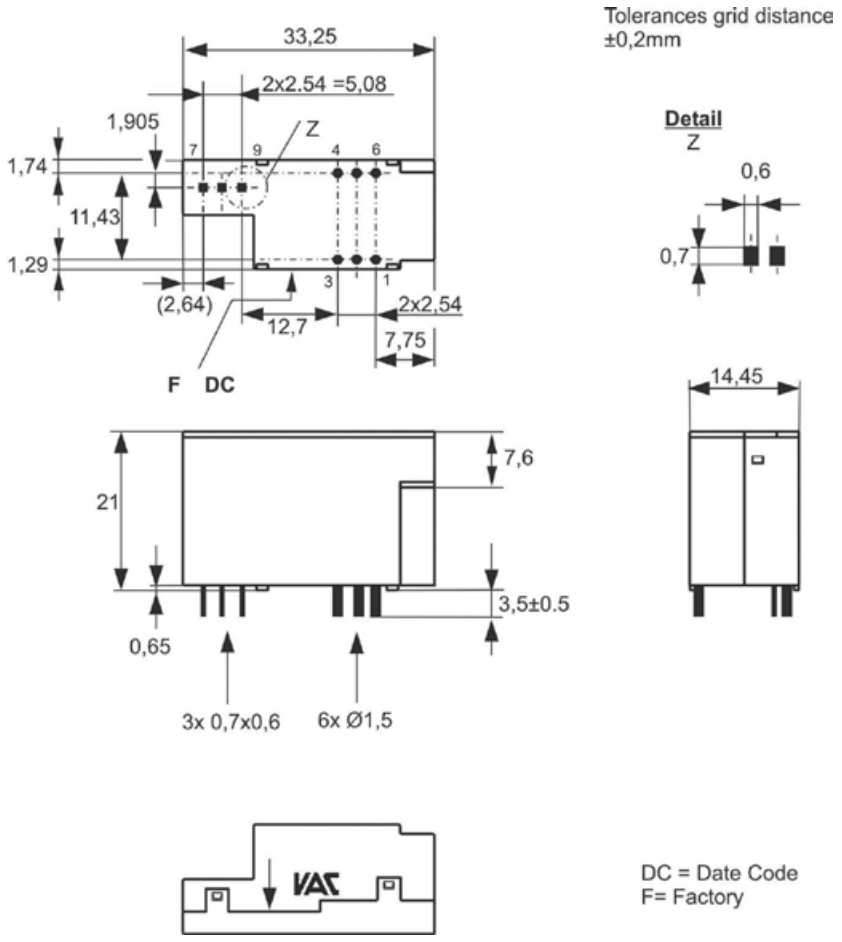




DC = Date Code
F= Factory

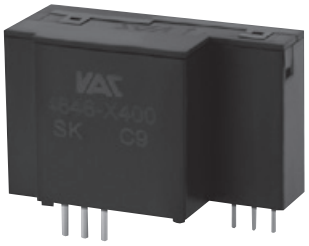
Photos for illustration purposes only

Drawing no. 7



Type

T60404-N4646-X410
T60404-N4646-X412
T60404-N4646-X413



Photos for illustration purposes only

CROSS-REFERENCE LIST

The sensors of the VAC type series can replace competitive products in many cases and generally offer superior performance with respect to accuracy, temperature drift and quality of the quiescent signal. The following table lists the available products with which the VAC sensors are electrically and mechanically compatible according to the data sheet comparison.

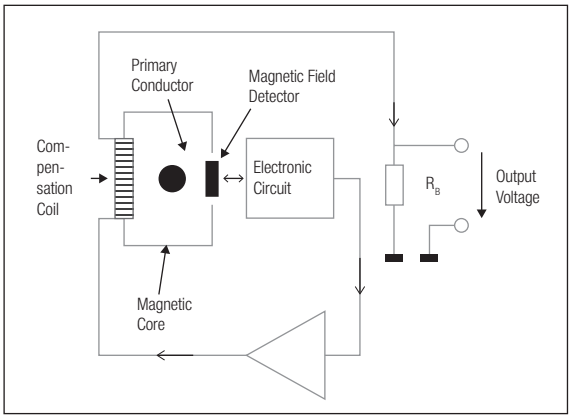
Minor differences may still exist and therefore the customer is responsible for the actual suitability in their specific application.

A large number of other competitive types can be replaced functionally with modifications to the PCB layout/circuit design. Please ask about these.

Item no. Type T60404-N…		LEM	Honeywell	Tamura	Telcon	Remarks
	4646-X653	CAS 6-NP[1,2] LTS 6-NP[1]		S22P006S05		
	4646-X652	CAS 15-NP[2] LTS 15-NP[1]		S22P015S05		
	4646-X651	CAS 25-NP[2] LTS 25-NP[1]		S22P025S05		
	4646-X654	CAS 50-NP[2]				
	4646-X663	CASR 6-NP[2] LTSR 6-NP[1]				
	4646-X662	CASR 15-NP[2] LTSR 15-NP[1]				
	4646-X661	CASR 25-NP[2] LTSR 25-NP[1]				
	4646-X664	CASR 50-NP[2]				[1] VAC-types without primary-conductor-opening
	4646-X763	CKSR 6-NP[2]				
	4646-X762	CKSR 15-NP[2]				[2] VAC-types 8 mm higher
	4646-X761	CKSR 25-NP[2]				[3] VAC-types 3 mm wider
	4646-X764	CKSR 50-NP[2]				[4] VAC primary pins ø 1.5 mm
	4646-X460	LAS 50-TP LAS 50-TP/SP1				[5] VAC-measuring range ± 128 A
	4646-X461	LAS 100-TP LAS 100-TP/SP1				
	4646-X300	LA 25-NP	CSNE 151 CSNE 151-005 CSNE 151-006 CSNE 151-007 CSNE 151-010		HTP25NP	
	4646-X400	LAH 25-NP			HTP25CPT[3] HTP25CPTH[1,3]	
	4646-X410	LAH 50-P/SP1		S23P50D15M1[4,5] S23P100D15M1[4,5]	HTP50CPT[3] HTP50CPTH[1,3]	
	4646-X412	LAH 50-P LAH 100-P LAH 100-P/SP3		S23P50D15[4] S23P100D15[4] S23P100D15M6[4]	HTP50CPT/2K[1,3] HTP100CPT/2K[3]	

FUNCTIONAL PRINCIPLE OF VAC CURRENT SENSORS

Two major advantages of the compensation current sensors are their 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 probe and controlled to zero by the electronics, generating a compensation current I_S in the compensation coil. This current and thus the output voltage across the burden resistor are proportional to the primary current I_P.



DIFFERENT SENSOR PRINCIPLES – ACCURACY OF THE CURRENT CAPTURE AND QUALITY OF THE OUTPUT SIGNAL

OPEN LOOP HALL EFFECT-SENSORS WITHOUT COMPENSATION COIL

The accuracy of these types of sensors differs from the two other principles. Their error over the whole temperature range is 7.5 % to 12 %. About half of this error is temperature-dependent. The series scattering of the temperature responses of the Hall elements prevents the possibility of compensation. Their output signal is also very noisy and has a lower bandwidth. Open loop Hall effect sensors can be used for less demanding applications.

CLOSED LOOP HALL EFFECT-SENSORS

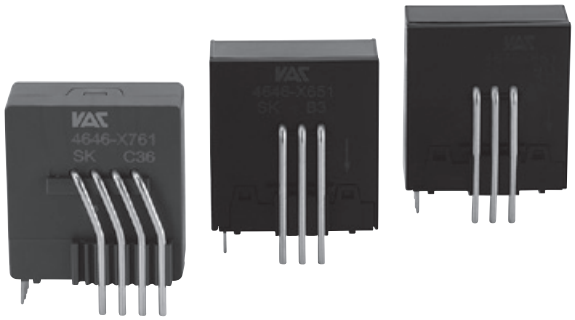
They achieve approximately half the accuracy of the VAC sensors, i.e. 2 % to 3 % over the permissible ambient temperature range which is smaller (typically -25 ... 85 °C instead of -40 ... 85 °C). Their output signal is superimposed by noise. This semiconductor noise is broadband and cannot be filtered out.

VAC CLOSED LOOP SENSORS WITH MAGNETIC PROBE

These types reach an up to two times higher accuracy than closed loop Hall effect-sensors over the entire application temperature range of -40 °C to + 105 °C or higher. This is more important than the error value only at room temperature. The superimposed noise of the VAC sensor has a low level, is high frequency periodic and therefore easy to filter. There is practically no noise.

VAC CLOSED LOOP SENSORS OFFER HIGH CONTINUOUS AND PEAK CURRENTS IN A VERY COMPACT FORM

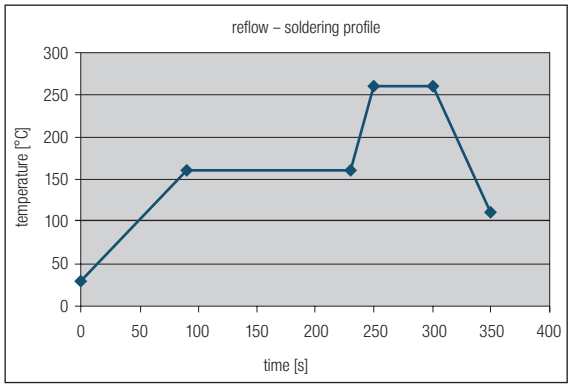
Types, like e.g. T60404-N4646-X764, detect maximum rms continuous currents up to 50 A and peak currents up to ± 150 A in a design with the dimensions 22.2 mm x 10.0 mm x 24.0 mm (L x W x H).



REFLOW-SOLDERABLE TYPES AVAILABLE

The types T60404-N4646-X681 and -X682 (not included in this brochure) are electrically and mechanically compatible to the types T60404-N4646-X661 and -X662. They are however reflow-solderable and are therefore suitable for the automated processing e.g. on PCBs, which are exclusivly or predominantly equipped with SMD components.

VAC recommends the temperature profile for lead-free soldering shown in the graph below. The optimal soldering profile for the specific application may however vary and must be determined by the user.

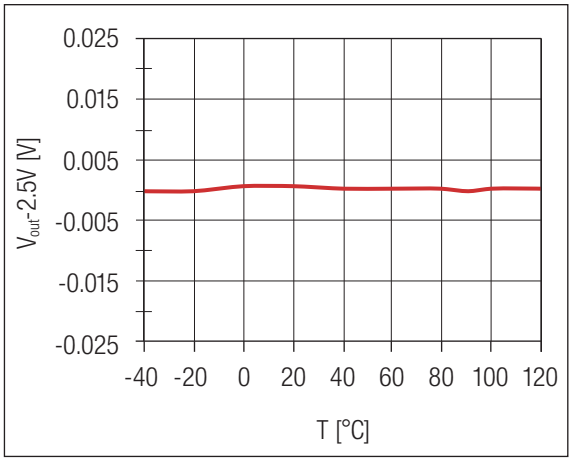


TYPICAL PERFORMANCE

Measured at VAC sensor with unipolar +5 V supply and voltage output.
T60404-N4646-X661, $I_{P,N}$ = 25 A, $I_{Pmax.}$ = ±85 A.

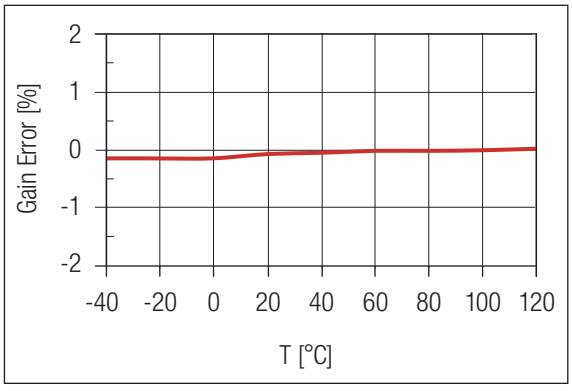
TEMPERATURE RESPONSE OFFSET

Low offset, almost temperature-independent, easily compensatable (I_P=$I_{P,N}$)



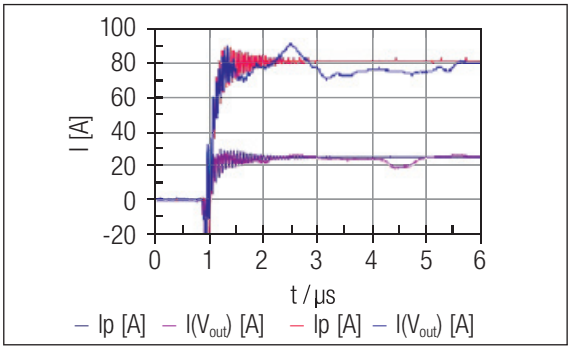
TEMPERATURE RESPONSE GAIN

Low gain-error, almost temperature-independent (I_P=$I_{P,N}$)



PULSE RESPONSE

The output signal V_{out} (here expressed as the equivalent of the input current) follows the input signal I_P with negligible delay and adapts quickly to the static value. Shown here for I_P = 25 A and I_P = 80 A.



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