

Bulk Current Injection Probe

1 Introduction

The TBBCI1-200K280 is a snap-on Bulk Current Injection probe, expanding the Tekbox product range of affordable EMC pre-compliance test equipment.

The BCI probe has been designed primarily for conducted immunity testing in the frequency range 150 kHz to 230 MHz, according to standard IEC / EN 61000-4-6. The insertion loss is 8 dB for most of its bandwidth and it is fully compliant with the insertion loss specification of IEC / EN 61000-4-6. The probe is individually characterized and usable in the frequency range 10 kHz – 300 MHz. It can inject severity levels 1, 2, 3 and level X up to 30V into a conducted immunity test set-up according to IEC/EN 61000-4-6.

The probe can also be used for RF current monitoring applications.



Picture 1: TBBCI1-200K280 Bulk Current Injection probe

The aperture of the RF current monitoring probe is 27 mm. The typical insertion loss is 8 dB and the typical transfer impedance is 26 dB Ohm.

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2 Specification

Compliance: IEC / EN 61000-4-6 insertion loss specification for BCI clamps
Characterized freq. range: 10 kHz to 300 MHz
Insertion loss: 8 dB typ.; 50 Ohm system (100 Ω loop impedance)
Transfer impedance: 26 dB Ohm typ.; 50 Ohm system (100 Ohm loop impedance)
Power rating: capable of injecting level 1, 2, 3 and stress level X up to 30V
150 Ohm test set-up according to IEC/EN 61000-4-6
Max. core temperature: 80 °C
Connector type: N female
Aperture diameter: 27 mm
Outside diameter: 92 mm
Height: 76 mm
Weight: 1.2 kg

3 Transfer impedance

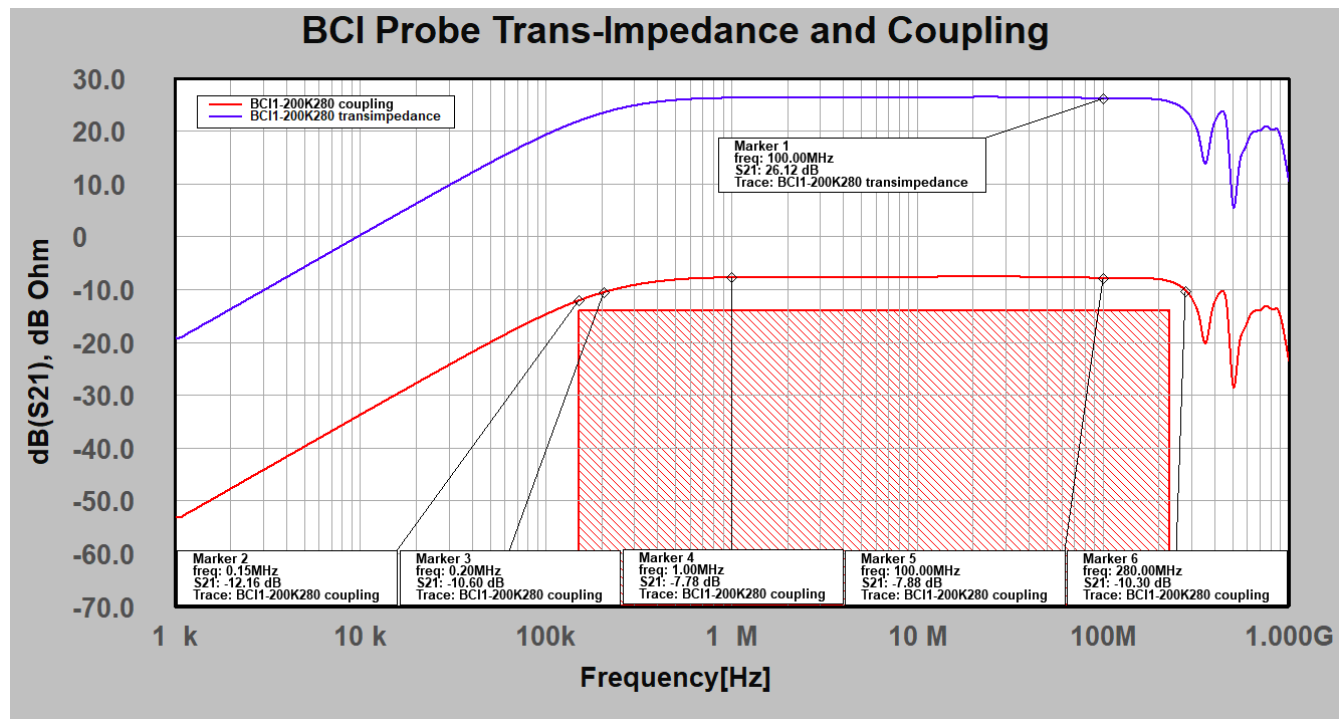


Figure 1: typical insertion loss and transfer impedance: 1 kHz to 1 GHz logarithmic, 50 Ω system (100 Ω loop impedance)

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4 Insertion loss and transfer impedance table

The table below shows typical insertion loss and transfer impedance data of a TBBCI1-200K280 BCI probe. Each current probe is delivered with its corresponding measurement protocol. This data can be used to calculate the required power for immunity testing or for the creation of a correction file for EMCview or similar EMC measurement software. The transfer impedance in dB Ω subtracted from the analyzer reading in dB μ V gives the corrected reading in dB μ A.

100 Ohm loop:

Frequency [MHz]	Insertion loss [dB]	Trans-impedance [dB Ω]	Frequency [MHz]	insertion loss [dB]	Trans-impedance [dB Ω]
0.01	-33,78	0,22	30	-7,63	26,37
0.02	-27,81	6,19	40	-7,66	26,34
0.03	-24,35	9,65	50	-7,70	26,30
0.04	-21,93	12,07	60	-7,74	26,26
0.05	-20,09	13,91	70	-7,78	26,22
0.06	-18,62	15,38	80	-7,82	26,18
0.07	-17,40	16,60	90	-7,85	26,15
0.08	-16,38	17,62	100	-7,88	26,12
0.09	-15,51	18,49	110	-7,89	26,11
0.1	-14,76	19,24	120	-7,90	26,10
0.2	-10,69	23,31	130	-7,89	26,11
0.3	-9,21	24,79	140	-7,89	26,11
0.4	-8,54	25,46	150	-7,90	26,10
0.5	-8,19	25,81	160	-7,91	26,09
0.6	-8,00	26,00	170	-7,93	26,07
0.7	-7,89	26,11	180	-7,97	26,03
0.8	-7,83	26,17	190	-8,04	25,96
0.9	-7,80	26,20	200	-8,11	25,89
1	-7,78	26,22	210	-8,22	25,78
2	-7,76	26,24	220	-8,38	25,62
3	-7,75	26,25	230	-8,57	25,43
4	-7,74	26,26	240	-8,80	25,20
5	-7,72	26,28	250	-9,08	24,92
6	-7,71	26,29	260	-9,42	24,58
7	-7,70	26,30	270	-9,82	24,18
8	-7,69	26,31	280	-10,30	23,70
9	-7,68	26,32	290	-10,93	23,07
10	-7,67	26,33	300	-11,75	22,25
20	-7,61	26,39			

Table 1: Insertion loss and transfer impedance: 10 kHz to 300 MHz, 50 Ω system / 100 Ω loop, typical data



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300 Ohm loop:

Frequency [MHz]	Insertion loss [dB]	Trans-impedance [dBΩ]	Frequency [MHz]	insertion loss [dB]	Trans-impedance [dBΩ]
0.01	-41,48	-7,48	30	-16,10	17,90
0.02	-35,56	-1,56	40	-16,09	17,91
0.03	-32,12	1,88	50	-15,95	18,05
0.04	-29,72	4,28	60	-15,89	18,11
0.05	-27,89	6,11	70	-15,78	18,22
0.06	-26,44	7,56	80	-15,80	18,20
0.07	-25,22	8,78	90	-15,68	18,32
0.08	-24,22	9,78	100	-15,70	18,30
0.09	-23,38	10,62	110	-15,64	18,36
0.1	-22,64	11,36	120	-15,55	18,45
0.2	-18,85	15,15	130	-15,51	18,49
0.3	-17,53	16,47	140	-15,39	18,61
0.4	-16,97	17,04	150	-15,20	18,80
0.5	-16,70	17,30	160	-14,99	19,01
0.6	-16,55	17,45	170	-14,71	19,29
0.7	-16,49	17,51	180	-14,48	19,52
0.8	-16,45	17,55	190	-14,27	19,73
0.9	-16,44	17,56	200	-13,97	20,03
1	-16,45	17,55	210	-13,65	20,35
2	-16,43	17,57	220	-13,36	20,64
3	-16,41	17,59	230	-13,11	20,89
4	-16,38	17,62	240	-12,89	21,11
5	-16,38	17,62	250	-12,72	21,28
6	-16,36	17,64	260	-12,57	21,43
7	-16,34	17,66	270	-12,49	21,51
8	-16,31	17,69	280	-12,54	21,46
9	-16,31	17,69	290	-12,84	21,16
10	-16,30	17,70	300	-13,50	20,50
20	-16,21	17,79			

Table 2: Insertion loss and transfer impedance: 10 kHz to 300 MHz, 150 Ω system / 300 Ω loop, typical data

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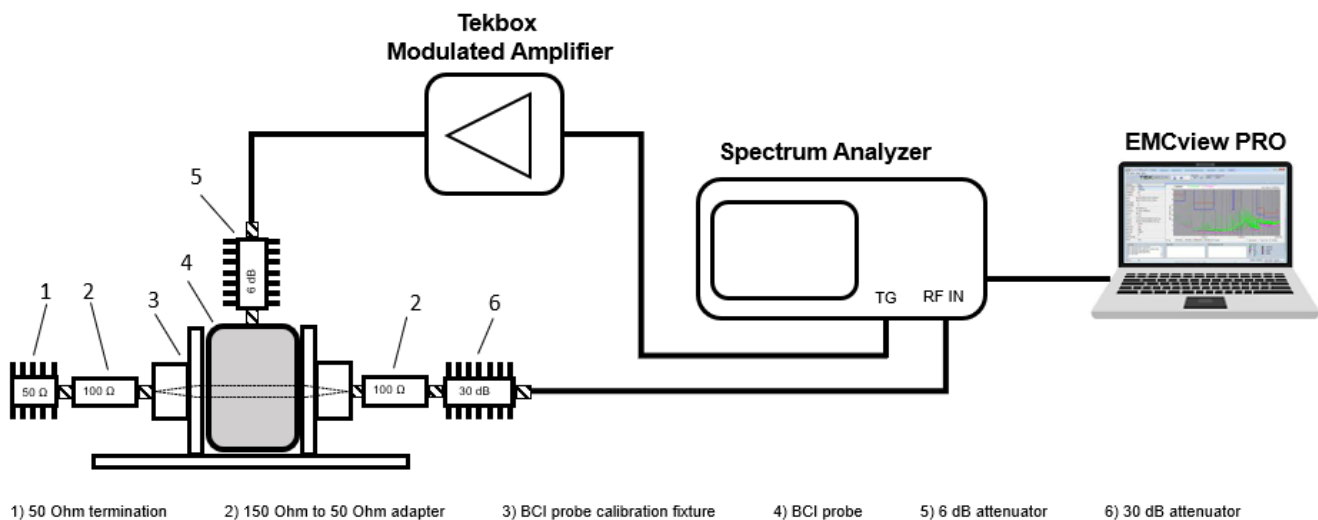
5 RF forward power requirements

IEC / EN 61000-4-6 specifies following test levels:

Level	Voltage level (e.m.f.)	
	U ₀ [V]	U ₀ [dBμV]
1	1	120
2	3	129.5
3	10	140
X*	Special	
* "X" can be any level, above, below or in between the others. The level has to be specified in the dedicated equipment specification		

Table 3: test levels, open circuit voltage

The test levels are open circuit voltages set at the EUT port of the coupling devices. For testing of the equipment, this signal is 80 % amplitude modulated with a 1 kHz sine wave to simulate actual threats.



Picture 2: EN 61000-4-6 150 Ω system / 300 Ω loop calibration set up using EMCview PRO

The test level is set at the output of the 150 Ω to 50 Ω adapter.

The specified test levels are open circuit voltages at the output of the calibration fixture.

The voltages measured during calibration must be multiplied by 3 to allow for the 50 Ω to 150 Ω conversion and again by 2 to reach the open circuit voltage. Hence, the measured voltage

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at the output of the 150 Ω to 50 Ω adapter is 1/6th the voltage of the desired stress level. In logarithmic figures, the measured voltage at the output of the 150 Ω to 50 Ω adapter is 15.5 dB lower than the open circuit voltage.

Test level	Test voltage e.m.f RMS [V]	Corresponding power at 150 Ω to 50 Ω adapter output, RMS [dBm]	Corresponding input power into probe RMS [dBm]	Power amplifier peak power requirement considering 6 dB attenuator and AM modulation [W]
1	1	-2.6	13.9	0.28
2	3	7	23	2.6
3	10	17.4	33.4	28.2

Table 4: PA forward power requirements, 300 Ω loop, 100 MHz

Table 4 shows the peak power requirements at midband, 100 MHz. The coupling factor for a 150 Ω system / 300 Ω loop, measured between probe input to 150 Ω to 50 Ω adapter output, has a value of -16 dB at this frequency. The required peak power increases at low frequencies.

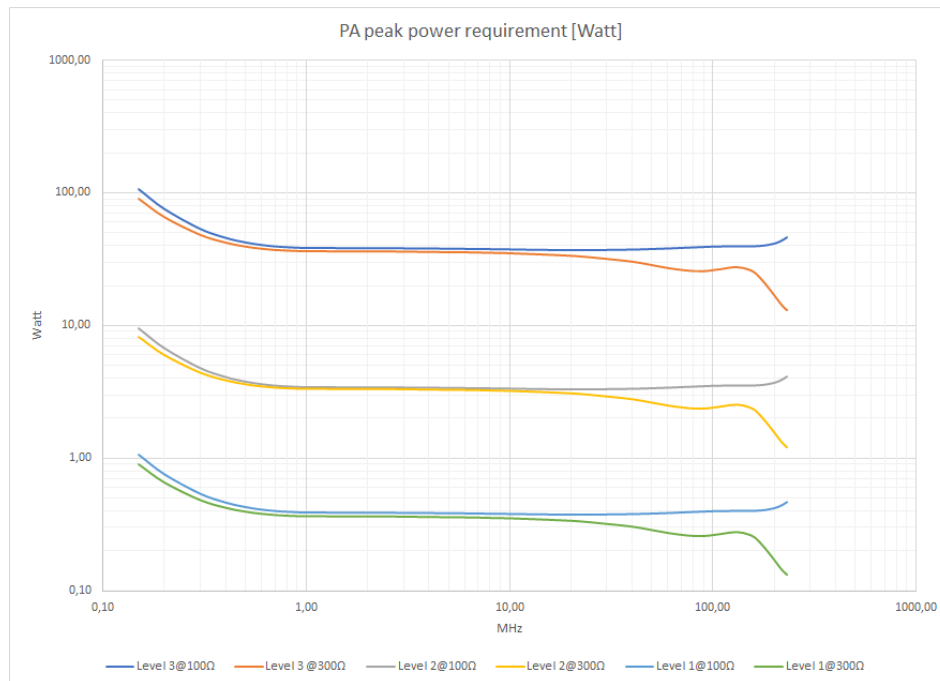


Figure 2: PA peak power requirement (includes 6 dB attenuator and peak power requirement for 80% AM modulation)

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Note that the power is given as RMS Power in Watt. The required peak power of the 80% AM modulated signal is 5.1 dB higher. The probe goes into saturation at stress levels of 30V into a 150 Ω system / 300 Ω loop.

Figure 4 shows the core temperature at 30V stress level and 22°C ambient temperature. The measurement time should be limited to 1 hour. At stress level 3, the core takes 4-5 hrs to reach 80°C.

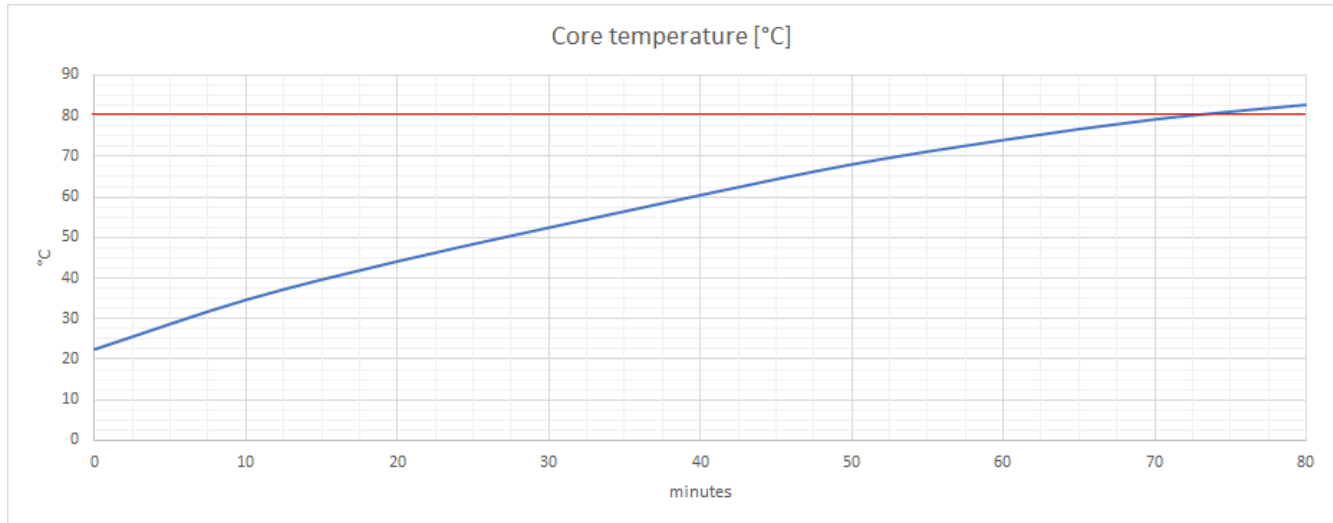
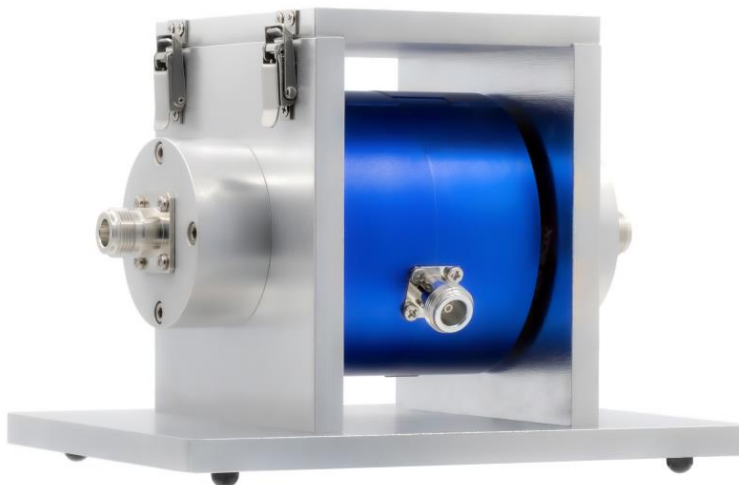


Figure 3: Core temperature increase over time at maximum stress level of 30V

6 Accessories

Tekbox supplies a calibration fixture for the TBBCI1 series of snap on BCI probes:



Picture 3: TBBCI1-CAL BCI probe calibration fixture

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In order to create a complete immunity test set-up, Tekbox supplies further accessories such as 150 Ohm to 50 Ohm transitions, attenuators, modulated wideband RF power amplifiers, RF current monitoring probes and EMCview / EMCview PRO software for automated calibration and measurement.

7 Ordering Information

Part Number	Description
TBBCI1-200K280	Snap on BCI probe, beech-wood box, calibration protocol
TBBCI1-CAL	Calibration fixture for TBBCI1 current probe series
TBCDN-50-150	50 Ohm to 150 Ohm adapter, N-male to N-female, 4W
TBATT-6dB-10W	6 dB attenuator, N-male to N-female, 10W
TBATT-6dB-25W	6 dB attenuator, N-male to N-female, 25W
TBATT-6dB-50W	6 dB attenuator, N-male to N-female, 50W
TBATT-6dB-100W	6 dB attenuator, N-male to N-female, 100W
TBATT-30dB-10W	30 dB attenuator, N-male to N-female, 10W
TBATT-30dB-25W	30 dB attenuator, N-male to N-female, 25W
TBATT-30dB-50W	30 dB attenuator, N-male to N-female, 50W
TBATT-30dB-100W	30 dB attenuator, N-male to N-female, 100W
TBMDA5	RF amplifier, 150kHz-400 MHz, 2W, AM/PM modulator
TBMDA6	RF amplifier, 150kHz-250 MHz, 25W, AM/PM modulator
EMCview PRO	EMC software for emission and immunity testing

8 History

Version	Date	Author	Changes
V 1.0	29.9.2022	Mayerhofer	Creation of the preliminary document
V 1.1	13.12.2022	Mayerhofer	Update of chapter 6
V 1.2	11.4.2023	Mayerhofer	Correction, chapter 5

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