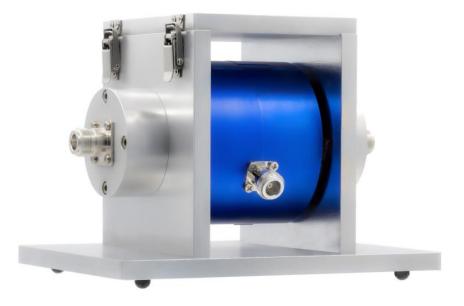**TEKBOX**
DIGITAL SOLUTIONS

BULK CURRENT INJECTION PROBE CALIBRATION FIXTURE

1 Introduction

The TBBCI1-CAL is a calibration fixture for the TBBCI1 series of Bulk Current Injection probes.

The calibration fixture is used in combination with a Vector Network Analyzer or Spectrum Analyzer equipped with tracking generator in order to measure the transfer impedance or insertion loss of BCI probes.

Every Tekbox RF current monitoring probes is shipped together with a corresponding calibration sheet containing the insertion loss and transfer impedance values vs frequency.

Calibration fixtures can be used for periodic inspection of the probes or for health checks, in case that a probe dropped and there is suspect that its ferrite core may have suffered damage.

Furthermore, calibration fixtures are used for the calibration of conducted immunity test set-ups. Refer to the *Conducted Immunity Basics* application note for detailed information on how to use calibration fixtures for this purpose. The application note can be download from the Tekbox web-site.
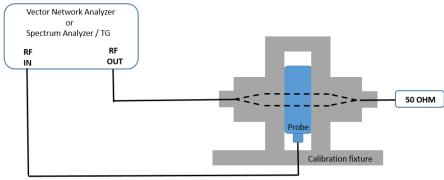
2 Operation

A calibration fixtures in combination with the installed probe represents a coaxial line with an impedance of approximately 50 Ohm.

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2.1 Transimpedance measurement

One side of the probe is connected to the signal source and the other side is terminated with 50 Ohm. The Vector Network Analyzer or Spectrum Analyzer receiver port is connected to the RF current probe. The output signal of the current probe is a function of the current flowing through the probe fixture and can be converted to obtain the trans-impedance characteristics of the probe.
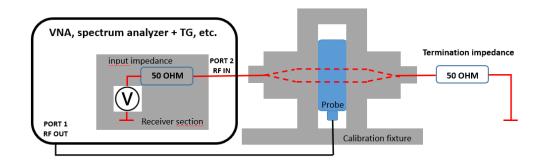

Set the Vector Network Analyzer or Spectrum Analyzer / Tracking Generator to the frequency range of interest and make a through calibration including the two coaxial cables.
Connect the RF output to the calibration fixture and the receiver input to the current probe and measure S21 (insertion loss / coupling).

The transfer impedance Z_t is calculated using the formula below:

Z_t [dBΩ] = P_{in} [dBm] – P_{probe} [dBm] +34 dB
or simply
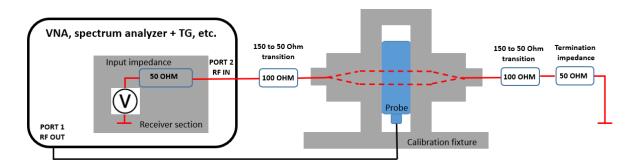Z_t [dBΩ] = S_{21} [dB] +34 dB

2.2 Insertion loss Measurement – 100 Ohm loop

Adding the source impedance of the VNA with the termination impedance of 50 Ohm results in 100 Ohm loop impedance. Measure S21 to characterize the insertion loss.
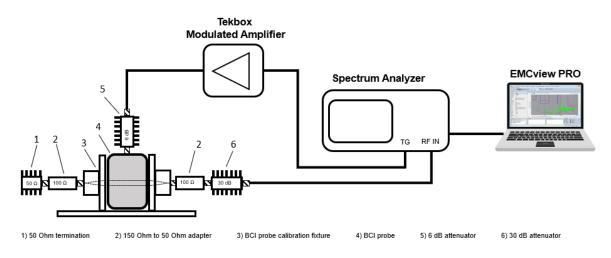
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2.3   Insertion loss Measurement – 300 Ohm loop

Depending on standard, the BCI-probe may be needed to be characterized in a 300 Ohm loop. Add two 150 Ohm to 50 Ohm adapters and measure S21.

2.4   EN 61000-4-6 300 Ohm loop BCI calibration set up

1) 50 Ohm termination   2) 150 Ohm to 50 Ohm adapter   3) BCI probe calibration fixture   4) BCI probe   5) 6 dB attenuator   6) 30 dB attenuator

- ▪ Test Level 1:   1V RMS, 1 kHz / 80% AM modulated
- ▪ Test Level 2:   3V RMS, 1 kHz / 80% AM modulated
- ▪ Test Level 3:   10V RMS, 1 kHz / 80% AM modulated
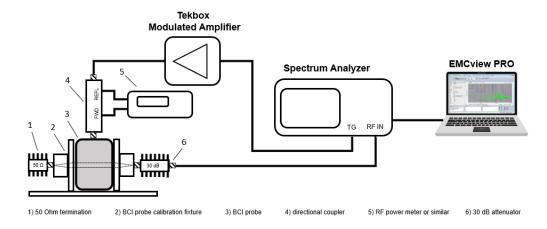- ▪ Test Level X: special (unspecified)

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 Ohm to 150 Ohm conversion and again by 2 to reach the open circuit voltage.

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

2.5   Example of a ISO 11452-4 / MIL-STD-461 / DO 160A calibration set up

1) 50 Ohm termination   2) BCI probe calibration fixture   3) BCI probe   4) directional coupler   5) RF power meter or similar   6) 30 dB attenuator

Substitution calibration method set up for pre-compliance purpose:

The automotive immunity standard ISO 11452-4 as well as immunity standards for defense and avionic products specify stress levels in terms of induced disturbance current.

Traditional calibration and test methods use current monitoring probes in order to create a control loop, thereby maintaining the required disturbance current. Levelling loops can be fooled by cable resonances. High impedance resonances cause the RF amplifiers output power to raise, in order to achieve the specified disturbance current. Similarly, low impedance resonances may significantly reduce the RF amplifiers output power. This situation is unrealistic of most real-life electromagnetic environments and could create a severe over-test or under-test situation.

In order to get around the over-test / under-test problems associated with the closed loop test method, the standards offer the substitution method (open loop), where the disturbance current is set by measuring current induced into a 100 Ohm loop. Forward and reflected power is measured using a directional coupler while setting the RF power to achieve the required disturbance current levels into the 50 Ohm load. During actual immunity test, the forward power level is set according to the value recorded during calibration.

3   Handling Instructions

Open the hinges at the four top corners of the fixture. Remove the top cover plate and clamp the probe over the center conductor of the fixture. Re-attach the top cover for the measurement.

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4   Ordering Information

Part Number	Description
TBBCI1-CAL	Calibration fixture for TBBCI1 BCI probe series, 50 Ω termination
TBBCI1-CAL-N	Spare N-connector for the TBBCI1-CAL calibration fixture
TBCDN-50-150	50 Ohm to 150 Ohm adapter for 300 Ohm loop calibrations

5   History

Version	Date	Author	Changes
V 1.0	8.12.2022	Mayerhofer	creation

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