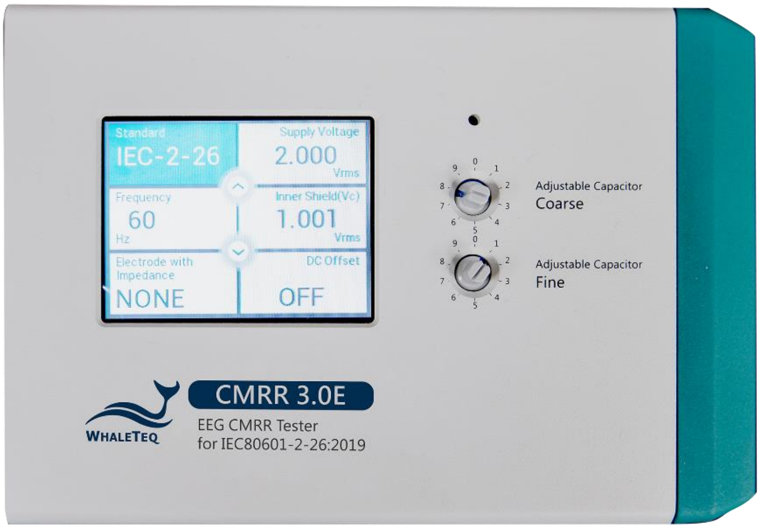
WHALETEQ

Common Mode Rejection Ratio Tester
For IEC80601-2-26:2019

CMRR 3.0E User Manual



(Revision 2022-- 2022.09.16)
PC Software Version V1.0.7.3

Disclaimer

WhaleTeq Co. LTD. provides this document and the programs "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

This document could contain technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in future revisions of this document. WhaleTeq Co. LTD. is under no obligation to notify any person of the changes.

The following trademarks are used in this document:

WHALETEQ is a registered trademark of WhaleTeq Co. LTD

All other trademarks or trade names are property of their respective holders.

Table of Contents

1 Introduction

CMRR 3.0E uses double shielding construction according to IEC80601-2-26:2019 standard and includes the following features

- Built-in sine wave signal generator. CMRR 3.0E provides 2 Vrms signal output required by IEC80601-2-26:2019 and the frequencies covers 50 Hz, 60 Hz, 100 Hz, and 120Hz.

- Use coarse and fine knobs to adjust the variable capacitance value Ct. The sum of Ct and Cx (stray capacitance) shall be 100pF.

- Built-in voltage measuring circuit for Vs and Vc voltages. Vs value indicates the signal voltage generated by built-in sine wave generator and Vc value is the voltage behind 100 pF capacitive voltage divider. User can easily confirm whether Vc value is half of Vs value while adjusting capacitor value Ct.

- Offer a precise and stable ± 150mV DC power supply.

- Provide imbalance impendence and DC offset options. Use MCU to control relay to switch on and off within the isolated circuit.

- Provide output terminals of Vs, Vc, Monitor and GND for monitoring applied voltages in the calibration process. For Monitor output terminal, it’s designed to confirm voltage value Vc. Due to the high impedance brought by 100 pF at 50/60/100/120hz, this causes typical multimeters being not able to measure precisely. Besides, it requires non-load output voltage at 10 Vrms in certain IEC standards. Therefore, WhaleTeq CMRR 3.0E uses 11:1 (110MΩ：10MΩ） voltage divider and designated circuit design as the best compromise solution for accuracy, circuit load, noise and input impedance of typical multimeters. Therefore, the Monitor terminal voltage shall be Vc/11 Vrms.

- CMRR 3.0E is equipped with a touch screen which enables to adjust and display all required test parameters on the screen.

- Via USB interface connection, CMRR 3.0E can be controlled by PC software or SDK (Software Development Kit).

- CMRR Standard Assistant software simplifies medical standards with test procedures, test options and pass criteria. User can easily select and click to conduct the required tests.

2 Electrical Diagram

Figure 2-1 indicates the electrical diagram of CMRR 3.0E. Ct is the adjustable variable capacitance and Cx is the stray capacitance between inner shield and outer shield.

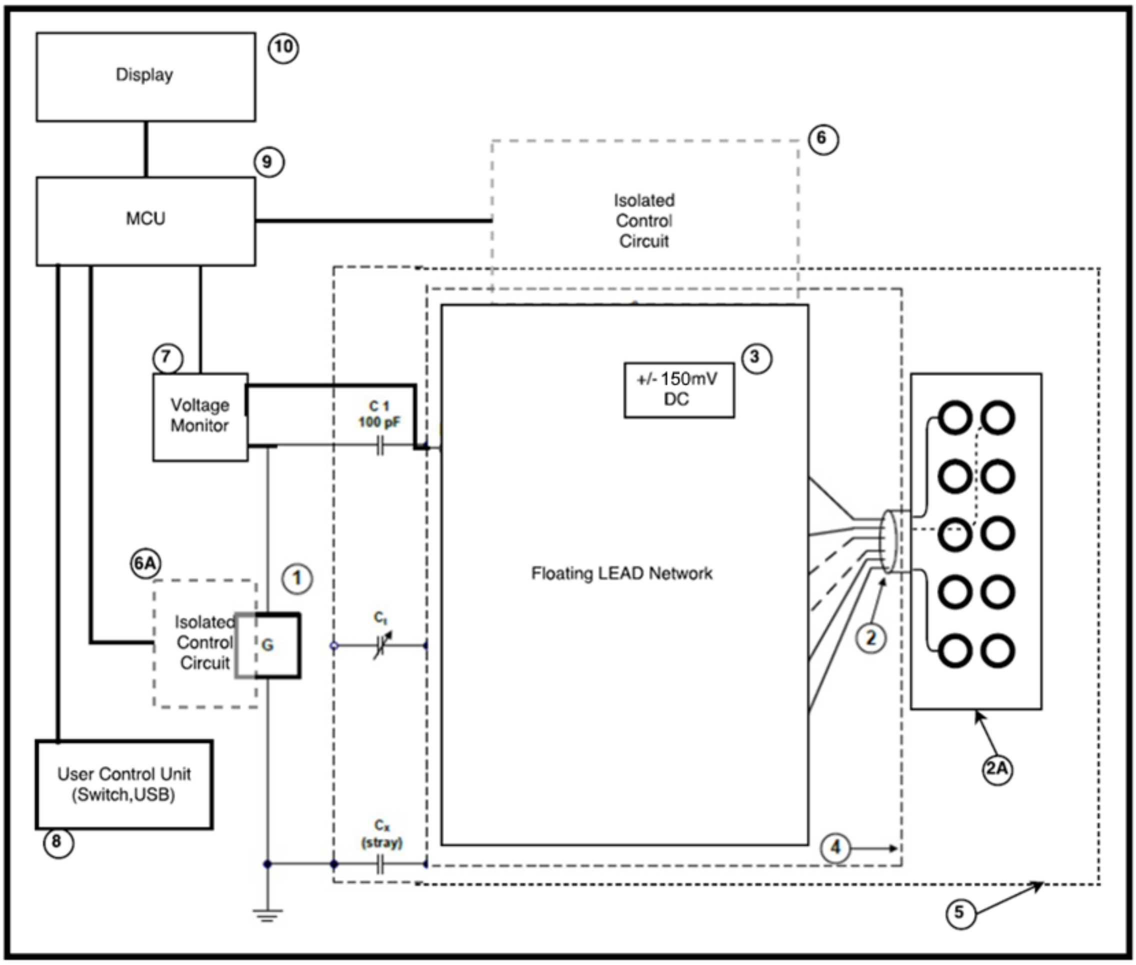


Figure 2-1, CMRR 3.0E Electrical Diagram

Item:

1 Signal generator
2 Internal connection wires
2A Electrode terminals
3 ±150 mV DC Power Source
4 Inner Shield
5 Outer Shield
6 Isolated control circuit (electrode)
6A isolated control circuit (signal generator)
7 Voltage monitor (Vs, Vc)
8 User control unit (Switch, USB)
9 MCU
10 LCD display module

*6 and 6A are the isolated circuits for isolating noises existed in power source and signal.

3 Set Up a Noise Free Test Environment

3.1 Reduce environmental noise and connect outer shielding to the ground plane.

It’s a must to reduce noise when testing EEG. Please refer to the below description for reducing environmental noise.

(1) Place a metal sheet or a metal bench under ECG DUT and CMRR 3.0E
(2) Connect GND terminal (outer shielding point) of CMRR 3.0E to the metal sheet or the metal bench.
(3) Connect the metal frame of EEG DUT to the metal sheet or the metal bench.
(4) Tester shall keep distance from the test system, to prevent from body capacitance effect. Else, tester shall touch the metal sheet or the metal bench to connect to the common ground plane.

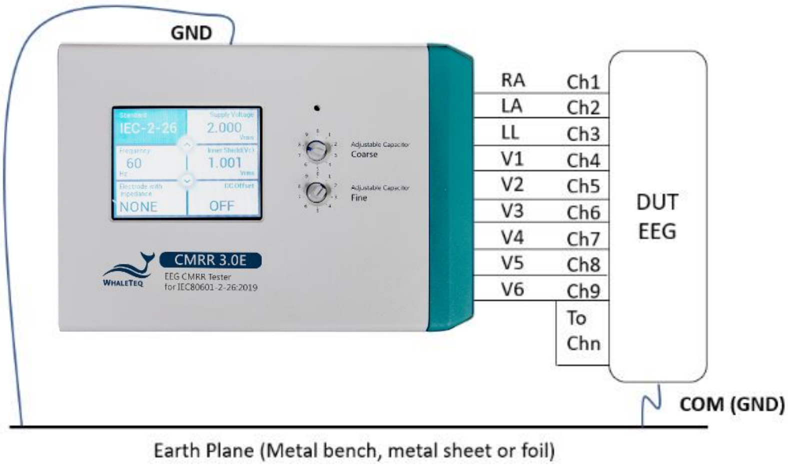


Figure. 3-1, Set-up CMRR 3.0E Test Environment

3.2 Shielding Covers for the Electrode Cables

(1) Please fasten the bottom shielding cover to the right-side panel of CMRR 3.0E for reducing main frequency interference. (see Figure.3-2)

Figure. 3-2, CMRR 3.0E with bottom shielding cover

(2) As the bottom shielding cover is connected to Vc, Vc would be unstable due to the outer noise. When Vs is 2V (Vc=1V), Vc has the possibility to exceed 1% tolerance. At the time, please fasten the top shielding cover with CMRR 3.0E, to control Vc voltage within 1% tolerance. (See Figure. 3-2)

Fig. 3-3, CMRR 3.0E with top shielding cover

4 Principle of the CMRR test

4.1 Common mode rejection ratio explained

A perfect device measuring a differential voltage should not respond to the level of common mode voltage which appears at both inputs. For example, a multimeter where the positive terminal is +100.017V and the negative terminal is +100.001V should theoretically indicate measured voltage of 16mV.

In practice, due to slight differences in resistances used in differential amplifiers, some of the common mode voltage will come through as an error. The common mode rejection ratio or CMRR indicates the ability of the equipment to reject these common mode voltages.

A scale of dB is normally used as the ratio can range from as low as 100 up to 100,000 (40dB to 100dB). A CMRR of 60dB indicates a ratio of 1000, and means that common mode voltages will be reduce by a factor of 1000. In the example given, equipment with a CMRR of 60dB would have the common voltage (+100V) reduced to 10mV, still a significant error relative to the differential voltage of 16mV. In practice, the common mode voltage is usually not more than 10 times the differential voltage, so a CMRR of 60dB would only result in a 0.1% error.

The most common source of common mode noise is mains voltages, i.e. 50/60Hz. Thus, CMRR in meters is usually specified at these frequencies. But it is important to note that CMRR varies with frequency.

Common mode rejection also varies with the impedance of the source, or more specifically the impedance imbalance, as the imbalance also upsets the measurement circuit. CMRR for multimeters is typically specified with a 1kΩ imbalance.

4.2 Test equipment

Refer to the standard for the test circuit.

From a testing point of view the series 100pF introduces significant complications, as it represents a very high impedance of about 30MΩ at 50/60Hz. This means that attempts to measure the applied voltage (10Vrms) with a normal multimeter will fail, because the meter has around 10MΩ input impedance. It is possible to use 1000:1 HV probe with an oscilloscope (100MΩ/3pF), but noise and other errors can be large. Even 100MΩ/3pF will load the circuit, so the voltage will change (increase) by about 5% after the

HV probe is removed, which should be accounted for if such probes are used.

WhaleTeq CMRR 3.0E equipment resolved the difficulty in measuring Vc by using 110MΩ/10MΩ 11:1 voltage divider and voltage measuring circuit to measure the common mode voltage Vc after 100pF automatically.

The 100pF also creates a problem with the position of the patient cable. If the cable is allowed to sit on an earthed plane, the stray capacitance can be enough to provide additional loading and reduce the actual common mode voltage. This stray capacitance is highly variable and thus can impact the test. For conservative tests, the cable should be supported off the earth plane, but remain above the earth plane in order to minimize noise.

A sine wave signal generator is built in CMRR 3.0E. It offers 2 Vrms signal required by EEG standard (IEC80601-2-26:2019) and the test setup becomes easy and time-saving.

Common mode rejection is also dependent on imbalance impedance test. For this reason, the test also introduces an imbalance of 10kΩ//47nF in one lead only. Experience from tests indicates that without this imbalance, there is usually no visible indication on the EEG, but with the imbalance readings typically range between 3-7mm (0.3 ~ 0.7mVpp). This suggests that the value of imbalance impedance is critical for the tests. Although the diagram in the standard shows all switches open, for the purpose of the test, all switches should be closed except the lead being tested and some tests are in the opposite settings instead. CMRR 3.0E uses MCU to control the relay switch, which makes it easy to set up various balance and imbalance impedance.

IEC 80601-2-26:2019 requires a DC offset of ±150mV. CMRR 3.0E uses MCU to control +/- 150mV DC offset and it is easy to set +/- 150mV DC offset with different imbalanced impedance electrodes. The CMRR 3.0E DC offset is supplied by an internal battery. The lifetime of this battery is estimated to be at more than 40 hours under continuous use. Therefore, its time in service should be long enough for tests that only last a few seconds each time. In case there is a need to replace the battery, user just need to remove the battery cover at the bottom of CMRR 3.0E and replace with a new battery.

5 Panel Function

5.1 Upper Panel

The upper panel of CMRR 3.0E is shown in figure 5-1. Please see below introductions for the functions of LCD touch screen and knobs:

Figure 5-1, the upper panel of CMRR 3.0E

The whole CMRR 3.0E operation can be done with the knobs on the upper panel. All of the parameters can be shown on the LCD touch screen.

5.1.1 LCD Touch Screen

The LCD touch screen displays all the options and test parameters.

The main page of LCD touch screen is used for select functions of "Standard", "Voltage", "Frequency", "Impedance" and "DC Offset" by touching the area.

Once selected, the area shall be with light blue background display. User can click the up arrow button or the down arrow button to switch between different options. For example, you can click the arrow bottom to quickly switch [Off], [20], [2.828], [0.5] and [2.0] Vrms for Supply Voltage under [Manual] standard.

Otherwise, user can double click the function to have all the options shown in a separated page.

5.1.2 [Coarse] Knob

Located at the right side of the LCD display, it is used to tune adjustable capacitance Ct to make its sum with stray capacitance Cx into 100pF. The coarse scale ranges by tens of pF, and the fine scale ranges by pFs.

5.1.3 [Fine] Knob

Located at the right side of the LCD display, it is used to tune adjustable capacitance Ct to make its sum with stray capacitance Cx into 100pF. The fine scale ranges by pFs.

5.1.4 70.71 Vrms Switch

A hole located above [Coarse] knob. Pressing the switch in the hole with a small-size screwdriver for 6 seconds launches the hidden 70.71 Vrms voltage setting function. When outputting 70.71 Vrms signal, user can press the hidden switch again or directly turn off the power switch, to stop the high voltage output.

Under the manual mode, the [70.71 Vrms] option can be selected to test a higher CMRR value.

5.2 Front Panel

The front panel of CMRR 3.0E is shown in figure 5-2. Please see instruction to each terminal as below:

Figure 5-2, the front panel of CMRR 3.0E

Connectors on the front panel are mainly used for power supply, USB connection and calibration.

5.2.1 Tapped Hole

The front and back panels each has two tapped holes for fastening the shielding cover or the shielding case which is a CMRR 3.0E optional accessory.

5.2.2 USB Connector

Once connected to a PC, CMRR 3.0E can be commanded by CMRR 3.0E PC software or CMRR 3.0E SDK (Software Development Kit).

5.2.3 [DC 12V] Terminal

It connects the DC 12V power supply bundled with CMRR 3.0E to provide the power required by operation.

5.2.4 Power Switch

It turns on or off the mains supply of DC 12V power supply.

5.2.5 [Vc] Terminal

It connects the common mode point inside CMRR 3.0E to Vc terminal directly. This is intended for use in equipment calibration.

5.2.6 [Vs] Terminal

The voltage output of CMRR 3.0E built-in sine wave signal generator. This is intended for use in equipment calibration.

5.2.7 [Monitor] Terminal

The output terminal of inner common mode point after it passes through 11:1 voltage divider. It measures the voltage of Vc decayed by a factor of 11 directly. This is intended for use in equipment calibration.

5.2.8 Grounding Terminal

Outer shield grounding that connects the metal sheet in figure 3-1 in tests to reduce noises.

5.3 Right Panel

The right panel of CMRR 3.0E is shown in figure 5-3. It is mainly used to connect each electrodes of EEG.

Figure 5-3, the right panel of CMRR 3.0E

5.3.1 [CM Point] Terminal

Same as [Vc] terminal, it connects the inner common mode point (also referred to driven-shield layer or inner shield) of CMRR 3.0E to this terminal. When the patient cable (electrode cable) is wrapped in foil as an outer shield, the outer shield should connect to this common mode point.

5.3.2 RA/LA/LL/RL/V1~V6 Electrode Terminals

Each electrode terminal can be connected to EEG electrode cables respectively.

6 Operation

6.1 Stand-alone Operation

Before operating CMRR 3.0E, the bundled DC 12V power supply has to be connected to the [DC 12V] connector on the front panel with the switch at the right side to be turned to [On].

All of the operations of CMRR 3.0E can be done with the touch screen and knobs on the upper panel. All the parameters can be displayed on the LCD touch screen.

6.1.1 Touch Screen for Setting Different Parameters

The touch screen can be used for selecting different functions such as Standard/Supply Voltage/Frequency/Inner Shield(Vc)/Electrode with Impedance/DC offset. In the main page, user can use the up arrow button or down arrow button to switch different options. Else, user can double click the function area to have all the options shown in a separated page.

6.1.1.1 Standard

Once the option for [Standard] is selected for IEC-2-26, the relevant setting options will be limited in accordance with the requirements of each standard.

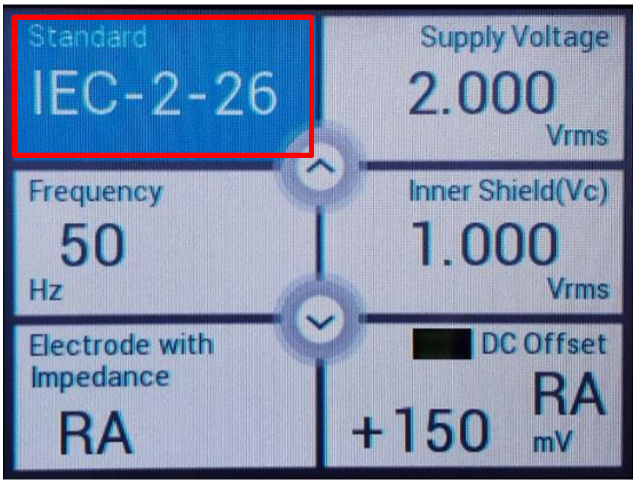


Figure 6-1, Options in "IEC-2-26 Standard"

6.1.1.2 [Supply Voltage] and [Frequency]

Select [Manual] in [Standard] option, and then select [Voltage]. Now the [Voltage] can choose [Off], [20], [2.828], [0.5] and [2.0] Vrms (200/56.6/8/1.422/5.66 Vpp) for Supply Voltage Vs (the output voltage of built-in sine wave signal generator) and 50/60/100/120 Hz for frequency.

After pressing the hole above [Coarse] knob for 6 seconds and launching the hidden voltage of 70.71 Vrms (200 Vp-p), a [70.71 Vrms] option becomes available for voltage Vs. Now it is possible to test a CMRR value that exceeds the requirement of standards. Although this voltage exceeds all of the standard requirements, it extends the range of CMRR value

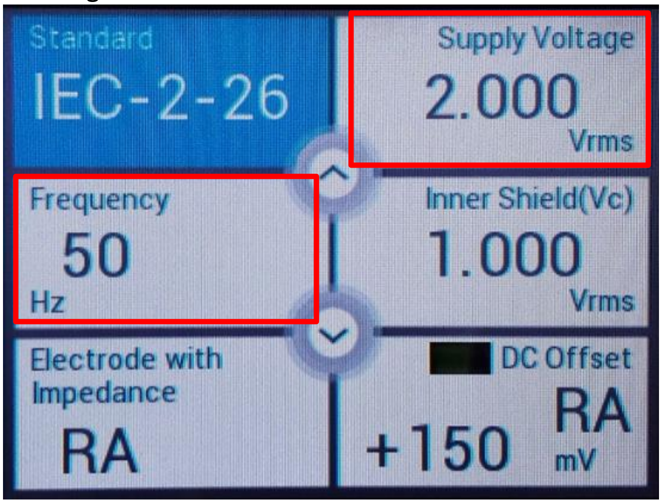


Figure 6-2, Options in [Supply Voltage] and [Frequency]

6.1.1.3 Inner Shield Vc

Once [Supply Voltage] (Vs) is selected, the [Coarse] / [Fine] knobs can be tuned to Inner shield Vc =Vs/2. This action automatically measures and monitors the voltage that passes variable capacitance Ct with built-in Vc voltage test circuit. By tuning [Coarse] / [Fine] knobs, the inner Ct is tuned until Ct+Cx (stray capacitance) =100 pF, where Vc will be half of the output of line frequency signal generator. For example, when Vs= 20 Vrms, Vc=10 Vrms.

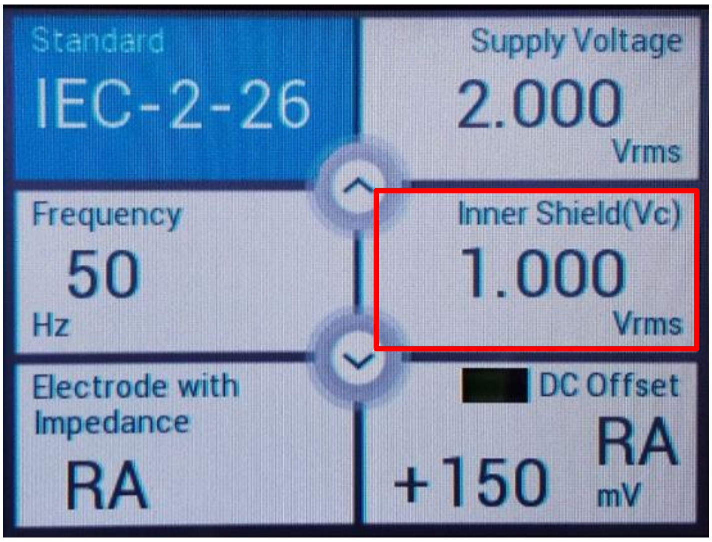


Figure 6-3, voltage display of “Inner Shield Vc”

6.1.1.4 Electrode with Impedance

Select [Electrode with Impedance] and click the arrow button (or double click to have all the options to show in the separated page) to choose whether to add 10KΩ/47nF parallel circuit to the test electrode (Electrode with/without Impedance). Adding 10KΩ/47nF to all or none of the electrodes is referred to balanced test. Adding 10KΩ/47nF to one of the electrodes, or all the electrodes except one, with the others in the opposite, is referred to imbalanced test. Available settings for CMRR 3.0E are as follows:

- Electrode with Impedance: None, none of the electrodes is added 10KΩ//47nF parallel circuit, balanced test
- Electrode with Impedance: RA (LA/LL/V1~V6), only RA (LA/LL/V1~V6) is added 10KΩ//47nF and the other electrodes are not, imbalanced test
- Electrode with Impedance: All, all of the electrodes are added 10KΩ//47nF parallel circuit, balanced test
- Electrode without Impedance: RA (LA/LL/V1~V6), all of the electrodes are added 10KΩ/47nF except RA (LA/LL/V1~V6), imbalanced test

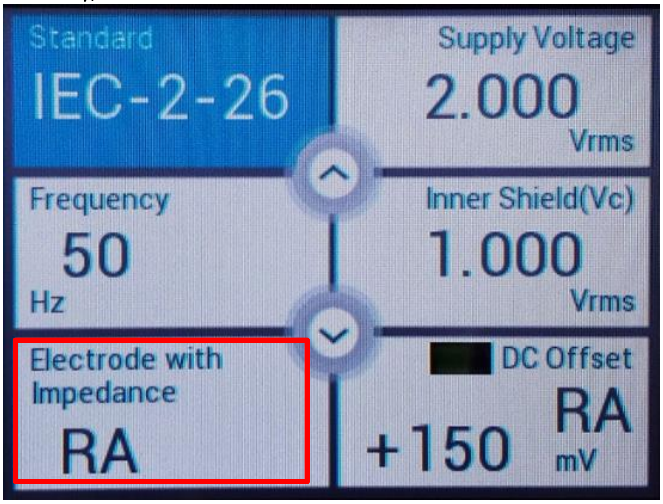


Figure 6-4, options in "Electrode with Impedance"

6.1.1.5 DC Offset

Select [DC Offset] and use the arrow button to choose whether to add ±150 mV DC offset or not. ±150 mV DC offset has to be tested on the electrode with imbalanced test. For example, choosing [RA] for [Electrode with/without Impedance] allows [±150 RA] to be chosen for [DC Offset]. There are 9 electrodes available for ±150 mV DC offset in total: RA, LA, LL, V1, V2, V3, V4, V5, V6.

As per the circuit diagrams in related standards, ±150 mV can be added only to [RA] for imbalance and DC offset testing.

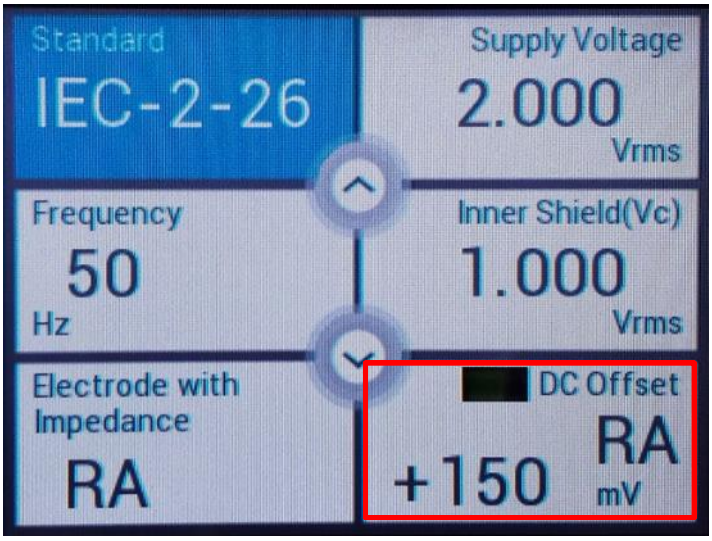


Figure 6-5, options in "DC Offset"

CMRR 3.0E uses a built-in battery supplying the electricity required by DC offset option. Before turning off the power, user must check and confirm DC offset is switched to "OFF". If not, it would keep consuming battery power in the power-off status.

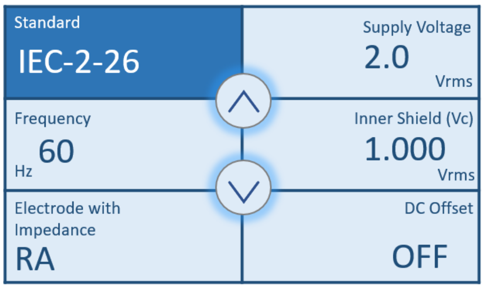
6.1.2 Test Exemplification

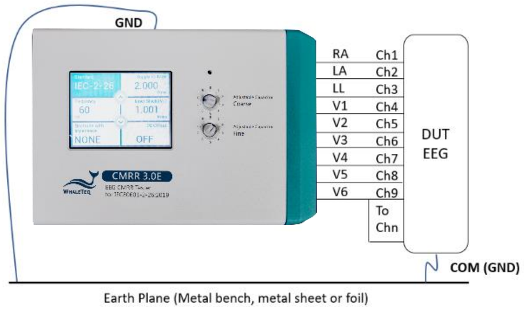
6.1.2.1 IEC80601-2-26: 2019

IEC80601-2-26 is the medical standard for EEG. Based on the requirement of IEC80601-2-26, the output amplitude of all channels shall not exceed 100 µVp-v (10 mm p-v at 0.1 mm/µV gain), WhaleTeq suggests use RA/LA/LL/V1/V2/V3/V4/V5/V6 terminals to proceed balance and imbalance tests with DC offset options. This is to ensure the absolute balance of CMRR 3.0E output signals and increase the precision of CMRR test.

The following test procedures are all followed the requirements stated in IEC80601-2-26 and can be taken as test examples of CMRR 3.0E. Due to the different naming rules between EEG and ECG standards, hereby we use Ch1, Ch2...etc, to prevent from further confusions.

1. Set up a noise-free test environment.
2. Disconnect electrode cables
3. Setting CMRR 3.0E "Standard" to IEC-2-26
4. Select "Supply Voltage" to 2.0 Vrms and "Frequency" to "50 Hz" or "60 Hz"
5. Adjust Coarse and Fine knobs until Inner shield (Vc) is ~1.000 Vrms
6. Connect Ch1 to RA, Ch2 to LA, Ch3 to LL, Ch4 to V1, Ch5 to V2, Ch6 to V3, Ch7 to V4, Ch8 to V5 and short Ch9 with Chn and connect to V6.





7. Select “Electrode with Impedance” to “RA”
8. Select “DC Offset” to “Off”
9. Measure EEG Ch1 output for at least 60 seconds
10. Select “DC Offset” to “+150 RA”
11. Measure EEG Ch1 output for at least 60 seconds
12. Select “DC Offset” to “-150 RA”
13. Measure EEG Ch1 output for at least 60 seconds
14. Select “DC Offset” to “Off”
15. Select “Electrode with impedance” to “LA”, “LL” ,“V1”, “V2”, “V3”, “V4”, “V5” and “V6” in sequences
16. Measure EEG Ch2~Ch9 output for at least 60 seconds.
17. Switch Ch10~Ch18 with Ch1~Ch9 and repeat step 7~16 to measure Ch10~Ch18
18. Repeat the switch procedures until Chn is measured

6.2 PC Software Operation

CMRR 3.0E can be connected to PC via USB cable. Once connect to PC, CMRR 3.0E can be controlled and commanded through PC software. User can also develop software by using CMRR 3.0E SDK (Software Development Kit) to fulfill automated test requirements.

CMRR 3.0E Assistant Software is the powerful add-on software provided by WhaleTeq, which enables PC to control CMRR 3.0E parameter setting and simplify standards into selectable options, including test sequences required by each standard.

6.2.1 CMRR 3.0E PC Software

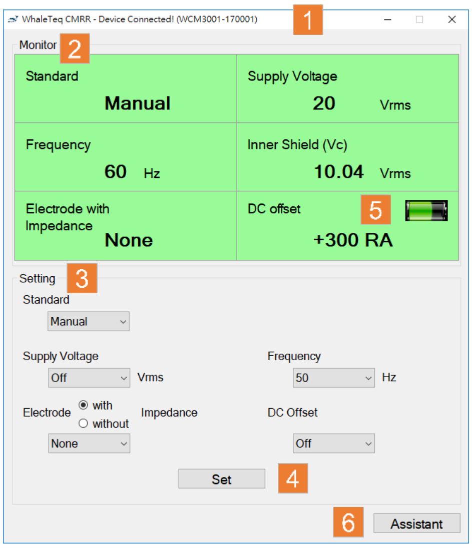
CMRR 3.0E PC software can control all the test parameters except adjusting Vc value via coarse knob and fine knob.

Once CMRR 3.0E is connected to PC through USB interface, CMRR 3.0E software will show the serial number in the title bar as shown in figure 6-6. The connection is successful if the serial number shows, otherwise the message “Device Not Found” will appear.

The parameters can be set once the connection is successful. The setting method is the same as stand-alone operation. After setting, click [Set] button to send the set parameters to CMRR 3.0E in order to change its parameter values.

Since the 150 mV DC is supplied by battery, remained battery capacity will be displayed in the [DC Offset] field.

Please note that under the CMRR 3.0E PC software mode, CMRR 3.0E Touch LCD screen shall display “PC LINK..” and user shall be able to adjust the test parameters in CMRR 3.0E PC software.



1 CMRR 3.0E connection status

2 CMRR 3.0E test parameter display

3 CMRR 3.0E test parameter adjustment

4 Send setting parameters to CMRR 3.0E

5 Battery capacity of DC offset

6 Launch CMRR 3.0E Assistant software

Figure 6-6, CMRR 3.0E PC software UI

6.2.2 CMRR 3.0E Assistant Software

Refer to figure 6-7 for software interface of CMRR 3.0E Assistant Software. This is mainly used to support test sequences required by IEC80601-2-26:2019. CMRR 3.0E Assistant Software can effectively simplify the complication of switching different test parameters.

Once select IEC-2-26 standard, follow the software guide to go through the setting of test parameters. Also, the test can be conducted manually or automatically.

Here we take IEC-2-26 as an example to explain the test sequences.

6.2.2.1 Step 1. Preparation

First, after clicking [IEC-2-26], the test step automatically starts at "Step 1. Preparation". It also explains required settings, as shown in the three green-shaded descriptions in figure 6-7:

1. No EEG patient cable is attached
2. The line frequency notch filter (if provided) of EEG is turned off
3. Set the ECG GAIN to 0.1 mm/uV

Make sure EEG to follows these three settings, and click [Next] to continue to next step.

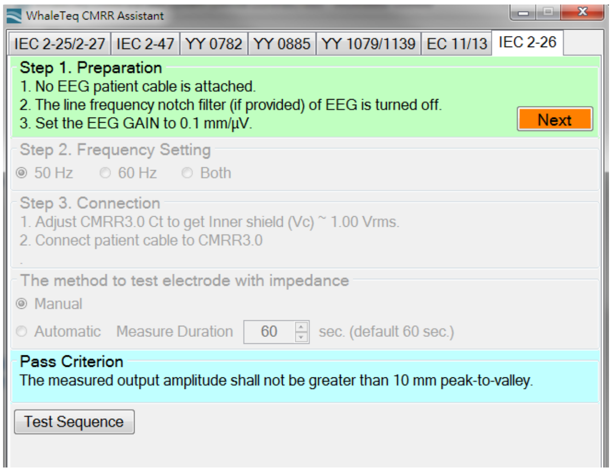


Figure 6-7, CMRR 3.0E Assistant Software

Before clicking [Next], if not familiar with the test sequence, user can click [Test Sequence] first to make the test sequence shown simultaneously, as shown in figure 6-8. The blue-shaded description texts in [Test Sequence] change as the test steps proceed. This makes the user to have a better understanding of the test sequences.

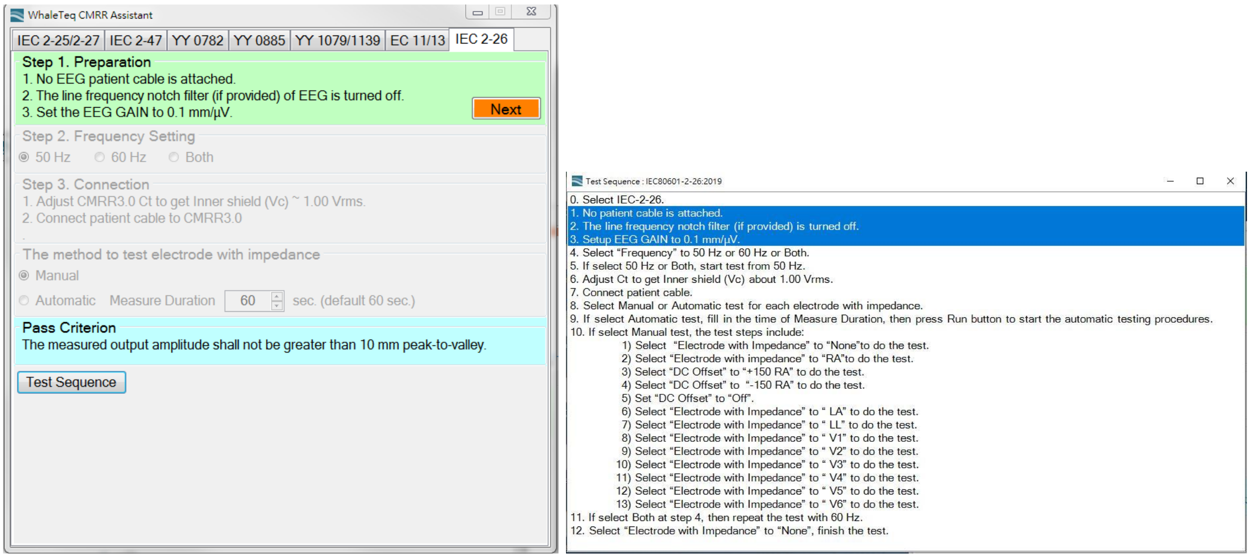


Figure 6-8, Software interface and test sequence description of CMRR 3.0E Assistant

6.2.2.2 Step 2. Frequency Setting

Set the line frequency to either 50Hz or 60Hz, or both. When both frequencies are selected, the setting of 50Hz will be performed first, and the same setting would be performed automatically with frequency replaced with 60Hz.

6.2.2.3 Step 3. Connection

Connect to patient cable. This includes two settings:

1. Tune Ct until Vc= 1 mV (tune [Coarse]/[Fine] knob)
2. Connect patient cable to CMRR 3.0E (after tuning Vc)

As the stray capacitance of patient cable affects the 100 pF capacitance value in CMRR 3.0E, Vc should be tuned after detaching patient cable.

6.2.2.4 Test Parameter Setting

Choose [Manual] of [Automatic] test. If manual test is chosen and [Test Sequence] is opened, the right window in figure 6-9 will appear after clicking [Run] button. According to test sequence of IEC-2-26 standard, [Electrode with Impedance] will automatically choose [None] for balanced test. The test time will be automatically counted in second and shown at the upper right corner, with total test time shown below it. After recording the test result, please click [Next]. The setting will be automatically switched to [Electrode with Impedance RA] and the time at the upper right corner will be returned to zero and counted in second again.

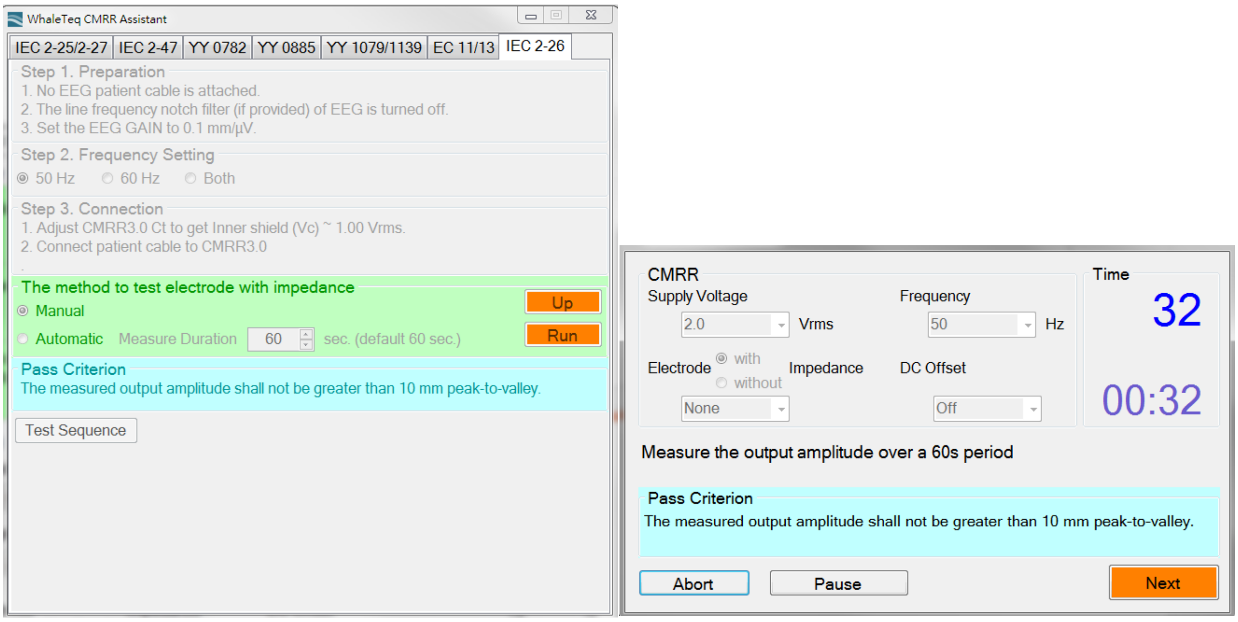


Figure 6-9, Software interface and run test windows of CMRR 3.0E Assistant

The display of [Test Sequence] is shown as the highlighted 1) step in figure 6-10, which indicates a balanced test when setting [Electrode with Impedance: None]. As [Next] button being selected, [Test Sequence] automatically highlights 1)~13) step by step. This explains the complete steps in IEC-2-26 test (refer to 6.1.2.1 showing detailed steps for IEC80601-2-26: 2019 as the example).

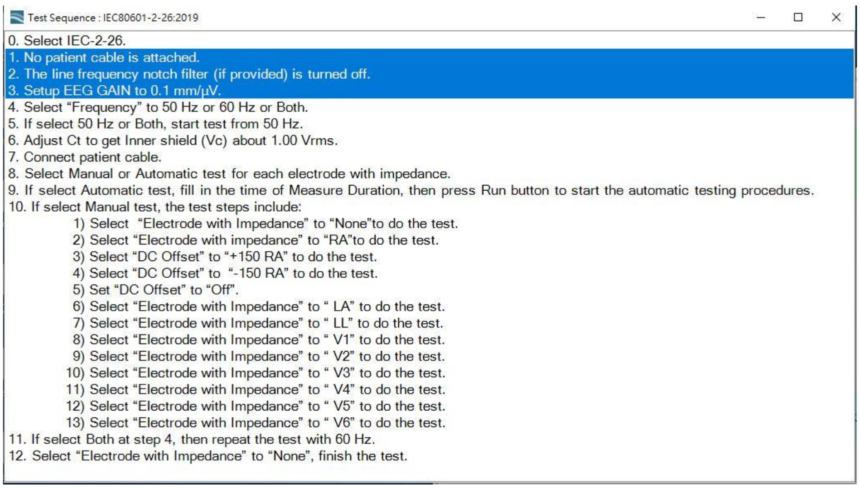


Figure 6-10, IEC-2-26 test sequence window

7 Software Development Kit (SDK)

WhaleTeq provides CMRR 3.0E software development kit. All operating parameters and options have corresponding commands in the software development kit. The software development kit contains DLL (Dynamic-link library), which will provide highly efficient program binding and version upgrade, supports C/C++ header and C# interface, and can also be integrated with third-party tools and script languages.

8 Calibration and Validation

Both WHALETEQ CMRR 3.0E and software have been system verified, and reports can be provided according to your needs.

WhaleTeq original calibration service is equipped with calibration equipment specially designed for physiological simulator to ensure the accuracy of calibration, and can calibrate the offset value of the device within the original specification of WhaleTeq. Under normal use, the device is recommended to be calibrated once a year. Please refer to the contact information and contact WhaleTeq for the original calibration service.
Note: If WhaleTeq detects that the components of the device are damaged and makes it impossible to adjust, it shall be sent back for maintenance.

9 Trouble shooting

Problem	Resolution
USB module (test unit) not recognized (USB driver is installed correctly)	Recognition of USB devices needs to be done in order: 1) Close WhaleTeq software if open 2) Disconnect the USB module for ~2s 3) Reconnect the USB module 4) Wait for the recognition sound 5) Start WhaleTeq software
USB module stops responding	Move the main function mode to “Off” and then return to the function being used. If this does not work, close WhaleTeq software, disconnect the USB module, reconnect the USB module and re-start the USB module.

10 Caution

10.1 Baseline noise test

When the CMRR 3.0E is connected to the power supply, it is impossible to eliminate high frequency noise from switching power supplies. Such high frequency noise is unlikely to affect the test. However, in case of doubt, the operator can select the “NOISE” setting, turn the unit off and remove the power supply. The internal relays in the isolated circuit are a special latch type and will hold the NOISE setting even with the power removed. This allows the test to be performed without any concern from noise arising from internal or external switching power supplies.

10.2 Battery power consumption for DC offset function

CMRR 3.0E uses a built-in battery supplying the power required by DC offset option. Before turning off the power, user must check and confirm DC offset is switched to "OFF". If not, it would keep consuming battery power in the power-off status.

10.3 Vs voltage drop with the multimeter of 1MΩ input impedance

"Vs" output of CMRR 3.0E would have a 0.4% voltage drop when a multimeter with 1MΩ input impedance is used to monitor "Vs" output.

WhaleTeq recommends to use a 10MΩ input multimeter (ex. Fluke 87V) to minimize the voltage drop range.

10.4 QC PASS Label

Warranty void if QC PASS label is removed or tampered with.

10.5 Instrument description

The professional testing instrument, not a medical device, is for testing only, and will not involve human or clinical use.

11 CMRR 3.0E Specifications

Item	Option	Spec
Supply voltage	0.5 / 2.828 / 20 / 2 / (70.71) (Vrms)	±1% [1]
CM point voltage	1.414 / 10/ 1/ (35.355) (Vrms)	±1% (0.25Vrms ±2%)
Frequency	50 / 60 / 100 /120 (Hz)	±1%
Electrode with Impedance	Change electrode via the touch screen of CMRR 3.0E	None/RA/LA/LL/V1~V6 /ALL
Electrode without Impedance	Change electrode via the touch screen of CMRR 3.0E	RA/LA/LL/V1~V6
Imbalance impedance, R	10kΩ	10kΩ ±1%
Imbalance impedance, C	47nF	47nF ± 5%
DC offset	Internal battery powered, can be added on RA/LA/LL/V1/V2/V3/V4/V5/V6	150mV ± 1% Up to 40hrs with intermittent use

100 pF capacitor	Use 11:1 (110MΩ:10MΩ) voltage divider to measure indirectly	100pF ± 5%
Environment	Intended for normal laboratory environment. The selection of critical components is known to be stable in the range shown. The 110MΩ divider may be affected by high humidity in excess of 85%.	15-30°C 10-75% RH

[1] Require to measure with the multimeter of higher accuracy.

12 Ordering Information

12.1 Package Contents

- CMRR 3.0E x 1
- CMRR 3.0E Software CD x1
- Top Shielding Cover x 1
- Bottom Shielding Cover x 1
- Compound terminal x 11
- USB Cable x 1
- Grounding Cable x 1
- 12V Power Supply Adapter, excluding power cord

12.2 Optional Software and Accessories

- CMRR Assistant Software: IEC80601-2-26
- External Shielding Case

13 Version Information

Version	Modify content	Issue date
20201231	Add Chap 7 Software Development Kit（SDK） Chap 8 Calibration and Validation Chap 9 Trouble shooting Chap 13 Version information	20210331
20210615	Add Chap 10 Cautions	20210615
20220916	Update Chap 8 Calibration and Validation	20220916

14 Contact Information

WHALETEQ Co., LTD

service@whaleteq.com | (O)+886 2 2517 6255

8F., No. 125, Songjiang Rd., Zhongshan Dist., Taipei City 104474, Taiwan