EMC Filter Design to Pass the EMC Test

Biricha Digital Power Ltd

Please visit our EMC Filter Design Workshop on: www.Biricha.com/emc to learn how to quickly design EMI input filters
Appendix - Easy Guide to Set Up the Rigol DSA-815 Spectrum Analyzer

• Setting-up the Rigol DSA 815 Spectrum Analyser for the Biricha EMC Filter Design Workshop Labs

  – This is not part of the workshop. The workshop lab notes will tell you exactly how to set up all the test equipment
  – For full detail of the workshop please visit www.biricha.com/emc

  – IMPORTANT: The LISNs that we use in the workshop labs have a 10dB attenuator. If you do not have a 10dB attenuator in your LISN please do not set the “reference Offset” to 10dB
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

Please now press the Power key to turn on

The screen menu always tells you what each soft key does

These keys are called “Soft Menu” keys (or Soft Keys) They change function depending on which previous keys you have pressed

If the screen menu has more than 1 page, it takes you to the next page

Image is publicly available and taken from: http://beyondmeasure.rigoltech.com/acton/attachment/1579/f-0502/1/-/-/-/-/-/DSA800_DataSheet.pdf
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Setting up the frequency range → 150kHz to 30MHz

1- Press FREQ Key

The screen will change to show you what each one of the Soft Keys does now
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Set the “Start frequency” to 150kHz

If at any point you make a mistake just press the “FREQ” button again.
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Entering 150kHz

3- Type in 150 using the key pad

4 - After you type in 150, the screen menu changes to units → select kHz

If at any point you make a mistake just press the “FREQ” button again
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Set the “Stop frequency” to 30MHz

1- Press FREQ Key

2- Press Stop Freq Key

3- Type in 2 using the key pad

4 - After you type in 2, the screen menu changes to units \(\rightarrow\) select MHz

If at any point you make a mistake just press the “FREQ” button again
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Set the units to dBuV

1- Press AMPT Key

2- Press the Units Key

3- Press the dBuV Key
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

- Set the Input Impedance to 50Ω and turn off Pre-Amp

1- Press AMPT Key

You can see that this menu has 2 pages

2- Press the down button to go to the second page of the menu

Make sure RF Preamp is off and Zin is set to 50Ω

Important: please DO NOT turn on the RF Preamp
You can easily damage the ins

If at any point you make a mistake just press the “AMPT” button again
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Resolution Bandwidth (RBW)
  – Your spectrum analyser has a bandpass filter, whose centre frequency moves from our start frequency to our stop frequency
    • i.e. it sweeps across our frequency range
  – The bandwidth of this filter is called resolution bandwidth \(\rightarrow\) RBW
  – EMC standards define what resolution bandwidth we need to use
    • Typically 9kHz or 120kHz
  – The lower our RBW, the better we can differentiate between different frequencies’ peaks but the longer our sweep time

• EMI Filter and Quasi-Peak Detector
  – The rate at which a filter rolls off and the method of quasi-peak detection is also set in the standards
  – In our spectrum analyzer this is called EMI Filter
    • As opposed to Gaussian Filter

• So before we can make any pre-compliance measurements we have to select the EMI filter option and also set our RBW
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Setting up the EMI Filter & Resolution Bandwidth

1. Press BW/DET Key

2. Press the appropriate Soft Key to select EMI Filter (it will go blue when selected)

3. Make sure Det Type is set to Pos Peak
   If Det Type (Detector Type) is not set to Pos Peak (Positive Peak), please press the Det Type Soft key and select Pos Peak

4. Set RBW to manual by pressing the Soft Key

5. Finally set RBW to 9kHz by typing 9 on the key pad and selecting kHz with the soft key

If at any point you make a mistake just press the “BW/DET” button again.
Setting up the Reference Offset to 10dB
- Our LISN has a 10dB attenuator built inside
- This means that all signals from the LISN are offset by 10dBs compared to what the spectrum analyser expects
  - So all displayed measurements will be off by 10dB
- If we set the spectrum analyser’s Reference Offset to 10dB it will automatically compensate for this so all our measurements on the Spectrum Analyser will be correct again
  - In other words the spectrum analyser automatically adds 10dB to the signal that arrives on its input

To set the Ref Offset (only if you are using a LISN with a 10dB attenuator)
- Press the “AMPT” key
- Then press the “Ref Offset” key
- From the key pad type in “10” and then select “dB” as the unit from the soft key
- If at any point you make a mistake just press the “AMPT” button again
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Setting up the Input Attenuation (Input Att) to 20dB
  – This attenuates the input by 20dB but scales all the measurement displays so that all the results that you read from the spectrum analyser are still correct
  – We do this to:
    • Protect the front end of the spectrum analyser
    • Stop the front end from going into compression/saturation and giving us the wrong results
  – As long as our signals are big, this is good practice
    • Which is usually perfectly sufficient for pre-compliance/debugging
    • If the signals get too small, you reduce the attenuation (but please don’t)
    • If it gets even smaller you can turn on the pre-amp (but please don’t)

• To set the Input Attenuation:
  – Press the **AMPT** key
  – Then press the **Input Att** key
  – From the key pad type in “20” and then select “dB” as the unit from the soft key
  – If at any point you make a mistake just press the **AMPT** button again
Getting Familiar & Setting-up the Rigol DSA 815 Spectrum Analyzer

• Setting up the User Key
  – This is located on the top right hand side of the Spectrum Analyser
    • This key can be programmed to carry out a series of commands (just like a Macro in a word processing package)
    – The “Display Line” is a green horizontal line drawn by the spectrum analyser which allows you to quick see whether any of your harmonics go above a certain limit → such as the limits in a standard

• To set the User Key to turn on and control the Display Line
  – First make sure that Display Line is **Off**:  
    • System → Display → Display Line to off
  – Then activate the recoding of the macro:
    • System → Work Setting → then turn on User Key
  – The unit is now recording your actions so we need to turn on the Display Line
    • System → Display → Turn on Display Line → press User Key to end recording of the macro
  – Finally press the FREQ button then User key and then turn the control knob
Rigol DSA 815 Spectrum Analyzer Summary

• Set-up for Filter Class:
  – FREQ Key then → Set up the frequency range to: 150kHz to 30MHz
  – AMPT Key then → Set unit to dBuV, make sure Z is 50Ω and Preamp is off
  – BW/DET Key then → Set to EMI Filter then RBW to 9kHz
  – Set Reference Offset to 10dB → AMPT Key, then Ref Offset key then set to 10dB
  – Set Input Attenuation to 20dB → AMPT Key, then Input Att key then 20dB

• Set up the Green Preset Key
  – To save the state so that it can be used by the Preset Key:
    • System → Reset → Preset Type → User6 → Save Preset → Type in Name → Ok
  – To set Preset Key to activate User6 setting when pressed:
    • System → Reset → Preset Type → User6 → Green Preset Button

• Set up the “User Key”
  – Make sure that the Display Line is set to off:
    • System → Display → Display Line to off
    • Then: System → Work Setting and turn on UserKey Set
    • Then : System → Display → turn on Display Line → User Key
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