CORNET Microsystems ED15SA Quick user's manual: 9/12/2008

CORNET ED15SA Electrosmog meter with build-in Spectrum Analyzer for 2.4GHz band is a pocket size, affordable tool for quick measurement of High frequency (RF) Radio wave field strength (100MHz - 3GHz), power density, and frequency spectrum of 2.4GHz band wireless applications. It is designed for RF radiation safety level measurement and general wireless applications such as: Mobile phone radiation safety level, Base station antenna power level (GSM, WiMAX, ,CDMA), DECT phone, WiFi WLAN, Bluetooth, cordless phone, Zigbee, microwave oven leakage, wireless home audio/video, radio transceivers and other RF applications signals.

ED15 SA has two operation modes: RF power-meter mode and Spectrum Analyzer mode. It has high sensitivity, wide dynamic range, and easy to read graphic LCD to display the frequency and signal strength of the RF signals. It is excellent for individual or company with Electromagnetic wave safety concerns. It is also an excellent tool for field measurement, installation aid and analysis of WiFi wireless LAN or any other wireless communications applications in the 2.4GHz frequency band.

Features:

Power-meter mode:
- Frequency range: 100MHz to 3GHz useful detection range
- High Dynamic range: 60 dB
- High sensitivity: -55dBm to 0dBm (25mv/m to 14.8V/m)
- Peak power density measurement: 1.5uw/m² to 0.58w/m² (auto scale)
- LCD digital power level and power density level display
- Moving Histogram display, and Analog style Bar Segment signal level display
- 8 high brightness LED to display power density level with 3 safety range indications
- Continues wave (AM/FM) and high speed burst RF (GSM, TDMA, PCS, CDMA, Wi-Fi, WiMAX)
- Super fast response time with easy reading color LED segment display

Spectrum Analyzer mode:
- Frequency range: Standard 2.4GHz frequency band (2.4GHz – 2.485GHz)
- Wide Dynamic range: 90 dB
- High sensitivity: -106dBm to -12dBm
- Frequency resolution: up to 333 KHz and 1 MHz
- Amplitude resolution: 0.5dBm
- Signals: Analog RF(AM,FM) and Digital RF (WiFi, Bluetooth, DECT, Spread spectrum)
- Display: Graphics LCD frequency spectrum and signal level display
- Operation mode: Spectrum, PeakHold, Hold, cursor-frequenccy/level display

General:
- LCD back light: 10 seconds auto-off, with manual on/off control
- Size: Small, compact handheld design, 65mmx130mmx25mm
- Battery operated: 9V DC (alkaline battery recommended) *not included in the package

Applications:

- High frequency (RF) Electromagnetic wave field strength measurement
- Mobile phone and Base station antenna radiation power density measurement
- Wireless communication applications (AM/FM, TDMA, GSM, DECT, CDMA, WiFi, WiMAX)
- 2.4GHz band Wireless network frequency spectrum and signal level measurement
- Bluetooth device, and RF wireless remote control device detection, testing and setup
- Spy camera, wireless bug finder
- WiFi wireless LAN setup, installation, detection, exploration, and optimization
- Wireless security system maintenance
- Radio transceivers power output level measurement
- Cordless phone, DECT phone radiation safety level measurement
- Microwave oven leakage detection
- Wireless Home audio/video devices, video sender, baby monitor
- Short range wireless devices, Zigbee, Wireless-USB, Wireless keyboard/mouse, etc.,
- Personal living environment EMF safety evaluation

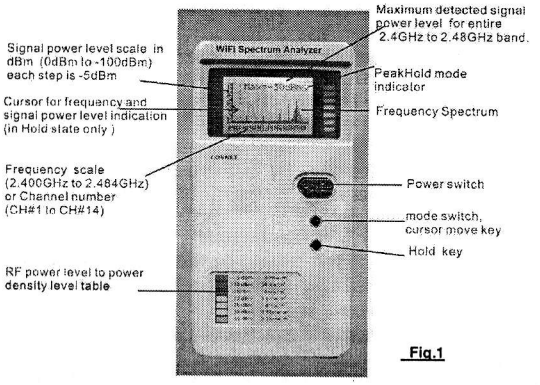


Fig.1

Usage guide:

There are two modes of operations of ED15SA: **power-meter mode** and **Spectrum Analyzer mode**. Push the first button below the power switch will change the ED15SA operation modes in (1) Power-meter-mode, (2) PeakHold-spectrum-mode, and (3) Normal-spectrum-mode in sequence.

1) Power meter mode:

(1) Put the 9V battery in the ED15SA, Handle the ED15SA with right hand in vertical direction, and push the power switch button. The ED15SA will come up with Field strength Power-meter mode first.
(2) The RF sensor is located in the left hand side of the ED15SA; Please do not cover the RF sensor area with hand or other objects.
(3) Measured RF field strength/power density is shown on the digital LCD display (with dBm and auto mw/m²,uw/m² scale)
(4) 8 LED lights. With Red, Yellow, and Green color on the right hand side of LCD window is used for quick RF signal level Indications. 3 Red LEDs are used to indicate the 3 safety range. The power level of each LED can be found in the table on the ED15SA front panel. The safety level standard of several countries can be found in the end of this manual as a reference.
(5) Histogram of previous 32 signal level readings are recorded and shown as vertical moving bar graph on the right of LCD display
(6) Analog style Bar segment display can be used for relative signal strength indication.
(7) Toggle the 2nd push button on/off while in power meter mode can "HOLD" the reading of the LCD display.
(8) Most high frequency RF antenna such as Mobile phone base station is vertical polarized (in vertical direction); therefore the ED15SA is normally used in vertical direction. Please rotate the ED15SA to find the maximum power reading direction to take care of high frequency RF wave reflections. The ED15SA can also be used to find the signal source location by pointing the ED15SA RF sensor area toward the signal source and looking at the moving Histogram.
(9) Most of modern communication devices (Mobile phone, Wireless LAN, Wi-Fi, etc.,) use digital communication technology with burst RF signals (Digital RF). When measuring this type of RF signals, several LED lights will blink at the same time; this is normal and can be used as an indication of Digital RF signals. The rapid on/off of RF signals used by Digital RF can be seen in the moving Histogram too. For Analog RF, continues waves (AM/FM) signals, the LED light will be stable. ED15SA measures the peak power density of signal with very quick response time. It is more accurate than the needle style of readout which is slow response and only shown the average value of signal power most of the time. The Mobile phone (GSM) handset will contact the Base station every several minutes with very short burst of signals. It can be seen in the ED15SA Histogram and power level indications. RF radio wave signal level

changes with the environment, temperature, weather, nearby objects, and Reflections. Therefore, relative comparison using Histogram to find the Maximum level area is suggested.
(10) ED15SA is a broadband High frequency (RF) type of Electrical field measuring device. It is used for applications such as Mobile phone base station antenna radiation, Microwave oven, Cellular/cordless phone, Radio transmitters, and WiFi wireless LAN installation aid. It is not for low frequency magnetic field measurement (AC power line, transformer, high voltage power transmission line, motor ...) which should be measured with Gauss-meters, such as CORNET ED25G RF/LF meter.

2) Spectrum Analyzer modes:

(1) There are two Spectrum Analyzer modes. Normal Spectrum mode, and PeakHold spectrum mode. The RF signal strength and Frequency Spectrum is shown on the graphics LCD display with level in dBm and frequency in GHz.
(2) **Two modes of spectrum analyzer operations**
(a) **Normal Spectrum mode** --- the ED15SA displays the real time frequency spectrum,
(b) **PeakHold Spectrum mode** -- the ED15SA hold and displays the peak value of the measured signal level for each frequency. PeakHold mode is good for monitoring fast changing RF signals, such as burst RF or Digital RF signals. A PeakHold indicator **(P)** will be shown on the top right corner of the LCD display in this mode. See **Fig.1**
* You can change the operation modes by toggling the "Mode/cursor-button" which is the first button below the power switch. The "Mode/cursor-button" will cycle through (1) Power meter mode (2) Normal spectrum mode (3) PeakHold spectrum mode.

(3) **Max. Signal Level** of the entire 2.4GHz band----In Normal mode or PeakHold mode, the LCD will display the Maximum signal level measured for the entire 2.4GHz band in the top of the display. This is good for applications such as Radiation Safety Level measurements, maximum level detections. The ED15SA updates the Max. Signal Level (dBm) readout for every scan of the entire 2.4GHz band. For Radiation Safety applications, signal power level to power density conversion reference table is in the lower left hand side of the ED15SA front enclosure. See RF radiation safety section for details.

* The ED15SA Spectrum Analyzer mode is a narrow band design. the signal indicated is for the specific frequency. For wide band RF signals such as WiFi wireless LAN, each channel bandwidth is 22MHz wide, you need to integrate all the signal levels in the 22MHz bandwidth to get the total signal power of it. The ED15SA power-meter mode is a broad band design; it shows the total power level measured in the bandwidth.

(4) **Mode/Cursor button** ------- The 1st push button below the Power Switch is used to change the operation mode of the ED15SA in between RF power-meter mode, Normal Spectrum mode and PeakHold Spectrum mode. It is also used to move the Frequency Cursor or Channel-Cursor while in "Hold" state.

(5) **Hold button** ------- The 2nd push button is used to get a snapshot or to "Hold" the scanning of the frequency spectrum. Once in the "Hold" state the spectrum scan will freeze and the LCD will display the signal level and frequency in the Frequency-Cursor location. Push the Hold button again; it will display the Average signal levels. Push the Hold button again; it will show the signal levels of 14 WiFi channels in Channel-Cursor location. Push the Hold button again to get out of the "Hold" state, and start the spectrum scanning again.

*Use the Mode/Cursor button (1st push button) to move the cursors while in "Hold" state.

(6) **Cursors** ------ The cursor in the "Hold" state can be used to measure the Signal level for the specific frequency or channel in the Frequency-Cursor or Channel-Cursor location. Use the "Mode/cursor button" (1st push button) to move the Cursor. Pushing and hold the "Mode/cursor button" a little bit longer time will move the cursor quicker along the horizontal axial. The Cursor will wrap around when it reaches the end of the screen.
* NOTE: the level displayed in the Channel-Cursor is the peak value within each channel. The Average value within the 22MHz channel bandwidth of each Channel is shown next to the Peak value. There are overlaps in adjacent WiFi channels. The cursor is used in the "Hold" state only.

3) LCD backlit auto-off control and Battery low indication ----- LCD backlit will ON when the ED15SA is power-up. It will auto-off after 10 seconds to save the battery power. To turn on/off the LCD backlit manually, go to power meter mode, get into HOLD state, then toggle the 1st push button to turn on/off the backlit manually. If the 9V battery is below the 5V threshold, the "BAT Low" indication will ON in the initial LCD screen when the ED15SA is power-up. The ED15SA continues working until the battery dies. When the "BAT low" is on; there will be no LCD backlit. Please replace the battery when "BAT low" is on, to make sure the ED15SA is working properly.

Spectrum Analysis tips:

There are two types of RF signals used in today's wireless communication systems, i.e. Analog RF and Digital RF signals. The traditional AM/FM Analog RF signals are continues wave signals. The frequency spectrum of this type of signal is stable and easy to capture. AM/FM radio, analog cordless phone, wireless spy camera, remote control, and Radio transceivers are some examples of Analog RF signals. Typical Analog RF spectrum is shown in **Fig.2**. Both Normal spectrum mode and PeakHold mode can be used for Analog RF signal.

Digital RF signal is burst type signals, it is used in digital communications such as: Mobile Phone, GSM, WiMAX, WiFi wireless LAN, Bluetooth, Zigbee, DECT phone and most of the new wireless Home audio/video devices. This type of signal is transmitted very fast in short bursts to share the frequency bandwidth between several different devices. In order to capture the frequency spectrum of Digital RF signals, tracking of the RF bursts are necessary. If the spectrum analyzer is out of sync with Digital RF burst signal or the burst ON time is short, only short spike of spectrum will be shown. The typical Digital RF signal frequency spectrum in Normal Spectrum mode is shown in **Fig.3**. In order to show the full spectrum of Digital RF signal, the PeakHold mode can be used. In PeakHold mode, the spectrum analyzer will overlap the PeakHolded signals captured several times to reassemble the whole frequency spectrum of the signal. See **Fig.4** for the spectrum in PeakHold mode for the same signal. It might need several seconds or minutes of capture time in PeakHold mode to show the whole frequency spectrum of the WiFi WLAN, or Bluetooth signals. **Fig.5** shows the Bluetooth frequency Hoping system frequency spectrum. **Fig.6** shows the spectrum for Microwave oven when it is ON, which has very wide frequency spread.

The 2.4GHz band WiFi wireless LAN has frequency coverage from 2.400GHz to 2.485GHz. The WiFi frequency band is divided into 14 channels. Each channel is 22MHz wide. There are also **overlaps in between adjacent channels**. See below for the frequency used by each WiFi channel. When ED15SA is in the "Hold" state and in the Channel display mode, the signal level displayed is the Maximum value within each channel. Since there are overlaps between adjacent channels, the maximum value may spread around several adjacent channels. *Note: (Channel#1, Channel#6, and Channel#11 are not overlapped with each other, and are used in typical WiFi Access points, there are two notches in the ED15SA LCD display frequency axial to mark these three channels). Next to the Maximum value of each channel, Average signal level of each channel is displayed. This can be used to see the distribution of signals in the WiFi frequency channels.

WiFi frequency spectrum captured by ED15SA can be used for WiFi WLAN installation and usage optimization. Try to re-assign the frequency channels used by the WiFi Access-Point to avoid the conflicts between each other. Data traffic information for each frequency and channel can be estimated by the frequency/channel spectrum too.

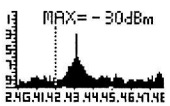


Fig.2 Analog RF

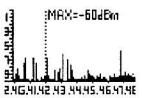


Fig.3 Digital RF w/o peakhold

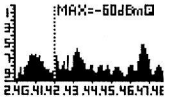


Fig.4 Digital RF with peakhold

Fig.5 Bluetooth

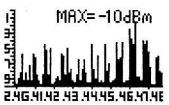


Fig.6 Microwave oven

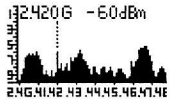


Fig.7. Hold, freq- cursor

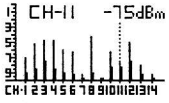
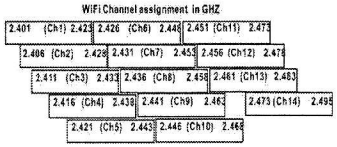


Fig.8 Hold, channel-cursor



RF radiation safety:

ED15SA can be used to monitor the RF radiation level for safety purpose. Many 2.4GHz band applications have high RF transmit power. For WiFi WLAN the maximum transmitter power output is 100mw which is 20dBm. For several WiFi device operated at the same time in the same location area it is possible that the RF radiation level will exceed the maximum safety level standard. The WiFi Access-Point location is important since it is busy most of the time and transmits a lot of RF power. Try to move the Access-Point to the location that is far from where the people stay most of the time. The 2.4 GHz DECT cordless phone base unit is also could be a problem. DECT phone base unit will poll all the satellite units (hand set) all the time to make sure it can communicate to each other. It will transmit RF signal all the time. Therefore Do Not places the DECT cordless phone base unit on the night stand next to your bed! ED15SA can be used to measure the RF radiation level for each frequency radiated from the device in the 2.4GHz band. Or broadband in 100MHz to 3GHz range. Microwave oven leakage can be monitored too. Table.1 shows the conversion table for power level (dBm) measured by ED15SA to power density level (w/m^2) which is used for maximum radiation safety standard. The Three RED color area is the National safety standard used by three different country. Try not to exceed these radiation levels if possible. (Relocate the device, use shielding, etc.,)

Field strength/power density table: (reference only)

Color	Power level	Power density	Indication	Action
RED3	-5 dBm up	0.18 w/m^2	Safety range#3 Italy standard (0.1w/m-sq)	Caution!
RED2	-10 dBm	0.058 w/m^2	Safety range#2 Swiss standard (0.04w/m-sq)	Caution!
RED1	-15 dBm	0.018 w/m^2	Safety range#1 Russian standard (0.02w/m-sq)	Caution!
YELLOW3	-20 dBm	0.0058 w/m^2		safe
YELLOW2	-25 dBm	1.8 mw/m^2		safe
YELLOW1	-30 dBm	0.58 mw/m^2		safe
GREEN3	-35 dBm	0.18 mw/m^2	Wireless LAN, WiFi typically in this range	safe
GREEN2	-40 dBm down	0.06 mw/m^2	Some signal source around	safe

Table.1 Signal power strength/power density conversion table

Note:
* Electromagnetic wave field strength/power density decades very fast with distance (distance square), keep a good distance from the high frequency RF signal source can reduce the high frequency radiation effect. Relocate the radiation source if possible, Alumina foil or window sun reflector film (silver color) can be used as an effective and cheap shielding material for most of RF radiations.
* The power density table is for RF radiation evaluation and reference only. Official RF safety radiation measurement procedure is complicate and should be handled by trained technical person with lab instruments. Safety range standard are listed here as a reference only. ED15SA is not a medical instrument, Please do not use it in medical, legal or other related applications.

The European Community provided general guidelines in its Council Recommendation of July 1999.[1] ICNIRP published similar guidelines in April 1998.[2] Table I gives a sampling of the international and national field-strength limit values for the general public and continuous exposure

		950Mhz	1850Mhz
International	Council Recommendation 1999/519/EC	42 V/m ($4.75W/m^2$)	59 V/m ($9.25W/m^2$)
International	ICNIRP Guidelines, April 1998	42 V/m ($4.75W/m^2$)	59 V/m ($9.25W/m^2$)
Austria	ÖNORM S1120	49 V/m ($6.33W/m^2$)	61 V/m ($10W/m^2$)
Belgium	Belgisch Staatsblad F.2001-1365	21 V/m ($1.18W/m^2$)	30 V/m ($2.31W/m^2$)
Germany	26. Deutsche Verordnung	42 V/m ($4.75W/m^2$)	59 V/m ($9.25W/m^2$)
Italy	Decreto n. 381, 1998	6 V/m ($0.1W/m^2$) 20 V/m ($1W/m^2$)	6 V/m ($0.1W/m^2$) 20 V/m ($1W/m^2$)
The Netherlands	Health Council	51 V/m ($6.92W/m^2$)	83 V/m ($18W/m^2$)
Switzerland	Verordnung 1999	4 V/m ($0.04W/m^2$)	6 V/m ($0.1W/m^2$)
United States	IEEE C95.1	49 V/m ($6.33W/m^2$)	68 V/m ($12W/m^2$)
China	Draft: National Quality Technology Monitoring Bureau	49 V/m ($6.33W/m^2$)	61 V/m ($10W/m^2$)
Japan	Radio-Radiation Protection Guidelines, 1990	49 V/m ($6.33W/m^2$)	61 V/m ($10W/m^2$)

A sampling of international and national field-strength limits for mobile communications frequencies.