

CleverLoad Operating Manual

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CleverLoad Features

- Integrated 50 ohm load and power meter
- Frequency response is within 0.25dB from 2MHz to 1.3GHz and 0.5dB to 300Khz
- Measures RMS RF power from -10dBm to +44dBm (100uW to 30W)
- Power measurement accuracy - 0.25dB resolution 0.1dBm
- Displays dBm or Watts - user selectable
- Power range extendable to +69.9dbm (~10KW) with external attenuators
- External attenuator value user selectable in 0.1dB steps from 2dB to 40dB
- Displayed power accounts for attenuator & indicator alerts user when an external attenuator is used
- Display shows measured RF power to 0.1dBm resolution along with a bargraph
- Full range or auto range display
 - Full range covers a 60dB range & the bargraph increments are 1dB per bar
 - Auto range provides a 12dB range which changes automatically with RF power and the bargraph provides a higher 0.2dB per bar resolution
- Peaking Mode enables +/- 3dB window with high resolution
 - Displays power in dBm with 0.1dB and relative power with 0.01dB resolution
 - Bargraph resolution is approximately 0.075dB per bar
 - Peaking Mode can auto range or remain fixed range - user selectable
 - Peaking Mode offers a re-centering feature
- Thermal alarm flashes a display warning if the termination temperature exceeds threshold. Alarm limits are settable in 1degC increments from 30deg. to 55 deg.C
- Device uses a soft power switch. Off time user selectable 2 min to 59 minutes.
- Remembers operating mode when repowered
- Powering options
 - Internal batteries either NiMh or Alkaline
 - External Power from 5 to 15V
 - USB power from computer or other USB compatible supply
- Battery indicator shows -full -half -empty or external power
- Datalog Capability with time stamp
 - Up to 2000 entries
 - Time interval user selectable
 - Very low power datalog mode to conserve batteries
- Sixteen level backlight display user selectable
- Two line 16 character display provides an easy to navigate user interface
- Low current consumption - 30mA typical while measuring with display backlight on
- Lo RF indication - displays time, date, and temperature when no RF present.



CleverLoad I/O & Controls

CleverLoad has a minimum number of I/O ports and controls as outlined in the pictures below.

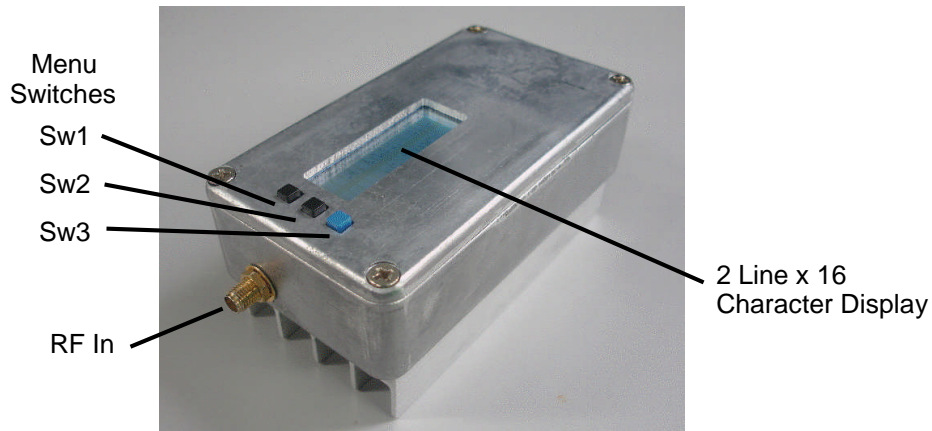


Fig. 1

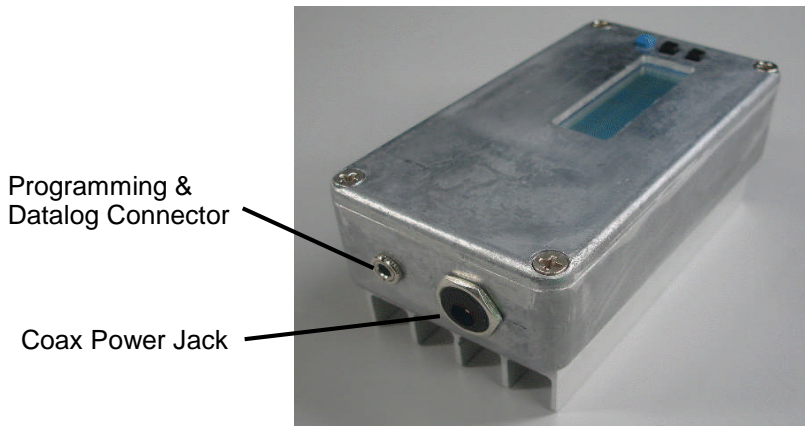


Fig. 2

Turning the CleverLoad On and Off

The unit does not have an off-on switch but instead uses a soft switch.

Turn the unit on by pushing Sw3 for about half a second. The unit will initialize and display a splash screen for a brief time showing the software version and user information. It will then resume measuring using the same settings and mode as it was using before it was turned off. If this is the first time the unit has been used after writing to the EEPROM in the calibration program, the device will start measuring in full scale mode.

To turn the unit off either

1. When measuring RF push Sw1 for about two seconds
2. Push Sw3 to enter the main menu then navigate to the final main menu item, 'Power Off' and press Sw3 again to turn the unit off.
3. If the turn-off time option is enabled the unit will turn off if no switches are pushed after a user selectable turn-off interval. To increment the turn-off time push any switch and the turn off time will be reset to the user selected turn off interval. While measuring RF increment the off time by briefly pushing Sw1.

As mentioned above, CleverLoad uses EEPROM to dynamically store and recall at start-up many housekeeping parameters so that when the unit is turned on measurements resume using the same state as existed when the unit was turned off.

These items include:

1. Measurement mode –full scale – auto scale – peaking
2. dBm / Watts display mode
3. Attenuator state – on / off and attenuator value
4. Turn off interval
5. Display backlight level
6. Temperature alarm

Using the three control switches

CleverLoad has three switches Sw1, Sw2, and Sw3 as shown in the figures above. They cause different actions depending on whether the unit is measuring RF or displaying menu items.

Switch Behaviour When Measuring RF

Sw1 can be pushed briefly to increment the off timer. If held down for more than 1.5 seconds it will cause the unit to power down.

Sw2 toggles the display between dBm and Watts. Note that the bargraph does not change between display modes, it always displays in dBm.

Sw3 will invoke the 'SL Utilities' menu and can be navigated to configure CleverLoad features as outlined below.

When any pushbutton is pressed, if the off timer is enabled, the off time is incremented.

Switch Behaviour in Menu Navigation

CleverLoad also uses the three switches to the left of the display to navigate and select menu items. Up and Dn appear on the display next to Sw1 and Sw2 in the main and submenus.

Pressing either button will move up or down to the next menu item. If at the top menu item, Up will not appear, and if at the bottom, Dn will be blanked to let the user know that they are at the end of the menu choices. Menus are navigated using the Up Dn buttons and the menu item is selected by pressing Sw3. The same procedure is used when entering or navigating submenu items.

Display Readouts

The display format varies depending on measurement mode.

Figures 3 and 4 show the full scale and Auto Range modes. In these modes the measured power is displayed numerically in either dBm or Watts using the last four characters of each line on the display. The remainder of the display is a bargraph. The top line of the bargraph shows the power range along with a battery level indicator. Line two displays the bargraph showing the measured power. In full scale mode, each bar is 1dB with a major tick every 5dB. The bargraph aligns to the right of the numeric characters. That is in full scale mode, if the reading was 0dBm the bargraph would show 10 bars and if 20dBm, thirty bars.

Figure four shows the same power displayed using the auto range mode. The section to the right of the bargraph displays the power measured and uses the same format in either full scale or auto range modes. The bargraph is a little different in auto range mode. The top line now has a 12dB range. Each bargraph bar is 0.2dB and each major tick is 1dB.

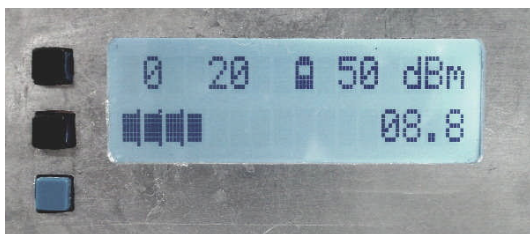


Fig. 3 Full Scale

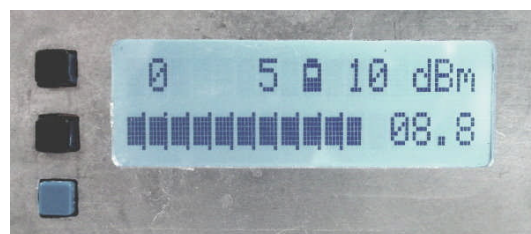


Fig. 4 Auto Range

Figure Five shows the readout in peaking mode. The top line indicates the measured power on the left in dBm with a 0.1dB resolution and the relative power on the right with a 0.01dB resolution. In this mode the bargraph is centered at 0.0dBr and each bar is approximately 0.075dbm. For further information on using this mode see the Menu items 'Set Meas Mode' peaking section.

If the RF input to CleverLoad is less than -9.9dBm the display will show a LoRf screen. This screen also displays the battery level, temperature, time and date.

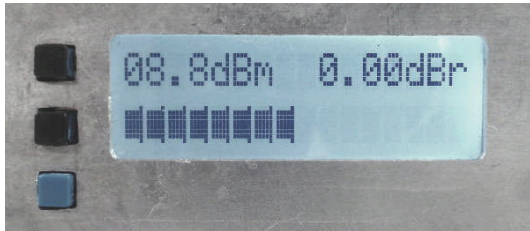


Fig. 5 Peaking Mode



Fig. 6 LoRf

CleverLoad Menu Items

Main Menu items have the 'SL Utilities' title displayed on line 1 and will show the following menu choices on line 2 as the Up and Dn switches are pushed

- Set Meas Mode - Submenu selects Full Scale, Auto Scale or Peaking modes
- Attenuator - Enables use of an external attenuator from 2.0 to 40.0dB
- Off Interval - Turns the off interval timer off or on and if on sets the off interval in one minute increments from 2 to 59 minutes
- Backlight - Selects any one of 16 backlight levels
- Temp Alarm - User selectable alarm triggered if unit temp is above 30 to 55 deg.C
- Change Time - The hour can be changed to accommodate Daylight Savings Time
- Power Off - Turns the unit off

If you accidentally navigate to and enter the wrong menu item pressing S3 will escape the menu without altering CleverLoad properties. After completing a menu task CleverLoad resumes measuring.

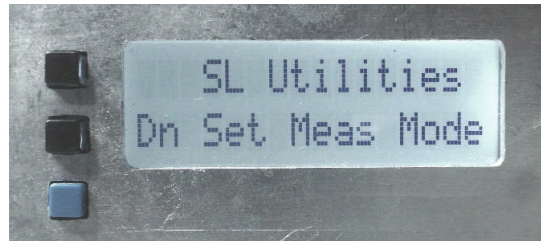


Fig. 7 Pressing Sw3 takes you to the Utilities Menu

Set Meas Mode

The user can select from three display modes shown in Fig, 3, 4, & 5; full scale, auto scale, and peaking. Use the Up Dn buttons to display the desired mode. Then press Sw3 to select the mode.

Full Scale

Full scale shows a 60 dB range bar graph with a numeric display on the right side.

The numeric display shows the power measurement in either dBm or Watts to three digits. The bargraph scale range depends on the attenuator setting. With no attenuator the displayed bargraph ranges from -10 to +50dBm, and depending on attenuator setting will change to 0 to 60 or 10 to 70dBm. Each bar on the graph is 1dB.

Auto Scale

The bargraph displays a 12dB range with an X0dBm upper limit where X is 0 to 7. In this mode each bargraph bar is 0.2dB. The numeric portion of the display remains the same in either auto range or full scale range

Power Indicator

In both Full and Auto Scale modes a power level indicator is shown on the middle of the first line. The icon indicates whether the unit is powered from line or battery. If battery powered it shows the battery capacity as full, half or empty.

Peaking Mode

The Peaking mode increases the resolution of the unit's numeric readout to .01dB although accuracy is not changed. It does however provide a readout along with a bargraph that provides a good way to adjust equipment for an RF maximum or minimum.

In this mode the first line contains a numeric value on the left side of the display which indicates the absolute power in dBm with a resolution of 0.1dB. On the right a relative value in dBr is shown with a .01dB resolution. The second display line shows a bargraph that is centered on 0 dBr and has a 0.075dB per bar resolution. This mode provides a +/-3dBr window. When measurements exceed this window the unit automatically re-centers the dBr reading.

There is a submenu in peaking mode accessed by pressing Sw3 that offers two options. The first can be used to re-center the dBr display by pressing Sw1. A second option selected by pressing Sw2, toggles the auto center feature on and off. If the auto center is turned off the unit will not track the input to re-center the signal. In this mode a window of about +/-4dB will be available. Outside this range the dBr display will saturate at either a + or - limit of about 4.5 to 5dB but accuracy is severely degraded beyond 4dBr.

Pressing Sw3 when in this sub menu returns the user to the main menu.

Attenuator

The attenuator mode along with an external power attenuator can extend CleverLoad's useful measuring range up to 69.9dBm. CleverLoad automatically adjusts the display readings to account for an external attenuator. Any attenuator between 2.0 and 40.0dB can be used. When the attenuator mode is enabled the display will show an "A" in front of the dBm reading to remind the user that the attenuator mode is in use. To enable the attenuator mode and select an attenuator value press Sw3 then use the Up Dn buttons to navigate to the 'Attenuator' menu item.

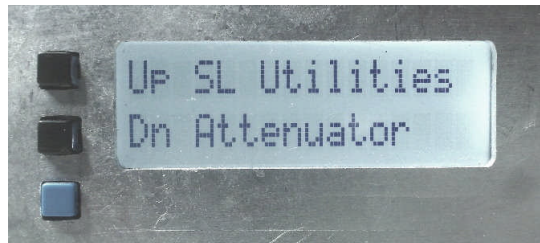


Fig. 8 Attenuator Menu Item

Pressing Sw3 will bring up the Set Off Set On display screen.

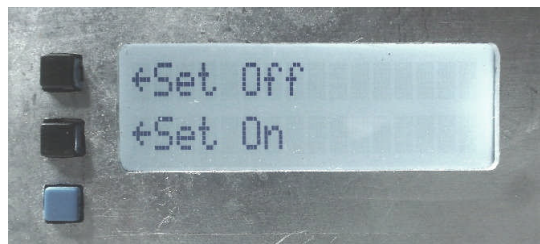


Fig. 9 Set Off /On Display Screen

Pressing Sw1 <- Set Off will turn off the attenuator mode and return to the measuring system. Pressing Sw2, <-Set On will bring up the next display screen used to set the attenuator value.

If this is the first time the attenuator mode has been used the attenuator value will default to 10.0dB, otherwise the value previously used will be displayed.



Fig. 10 Attenuator Value Screen with 10dBm default

Use the Up and Dn buttons to select the desired attenuator value. Then push Sw3 to save the value. Once saved the user is returned to the RF measuring subsystem. Measurements will now reflect the attenuator's value and an 'A' precedes the dBm heading

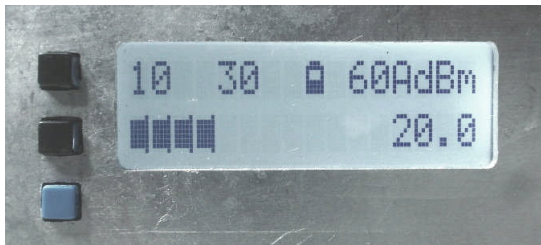


Fig. 11 Full Scale in Attenuator mode

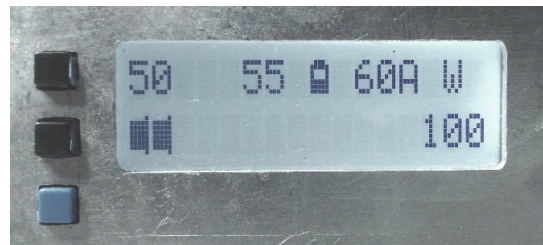


Fig. 12 Auto Scale in Atten mode reading Watts

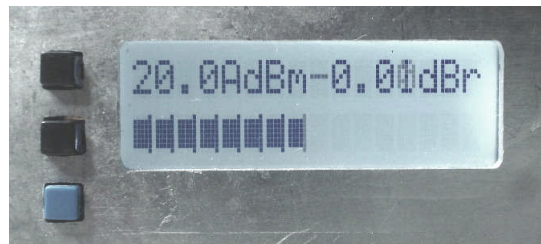


Fig. 13 Peaking mode with Attenuator

Note that using the attenuator mode doesn't alter CleverLoad's dynamic range so there will be a corresponding increase in the apparent lower power limit that CleverLoad can measure as the attenuator value is increased. Using a 10dB pad will result in a minimum power of 0dBm before the LoRf screen is displayed. Correspondingly using a 40dB attenuator will result in a lower measuring limit of +30dBm.

Off Interval

This feature will automatically turn the unit off after a user defined period of inactivity. The feature can also be disabled so that the unit remains on until turned off by the user. After initial EEPROM programming using the calibration software, this option is set to off. When the user enables Off Interval the parameter is saved. If the user disables Off Interval and subsequently re-enables it, The Off Interval will default to ten minutes.

To enable or disable Off Interval navigate to the SL Utilities Off Interval menu item and press Sw3.

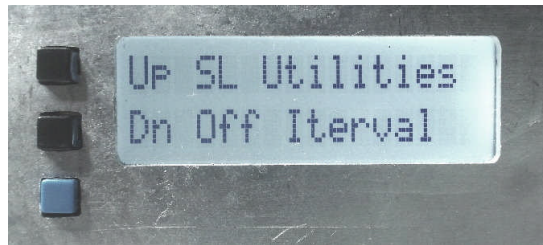


Fig. 14 Off Interval Menu

Pressing Sw3 will bring up the Set Off / On screen

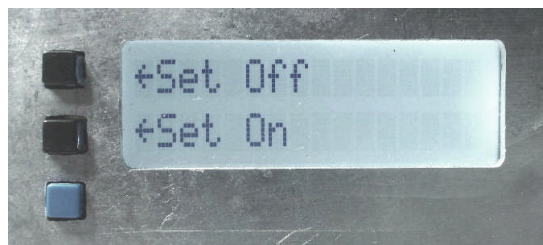


Fig. 15 Off Interval Off / On screen

Pressing Sw1 <- Set Off, will disable Off Interval and send the user back to the measuring subsystem.

Pressing Sw2, <-Set On, will bring up the next display screen used to set the off interval.

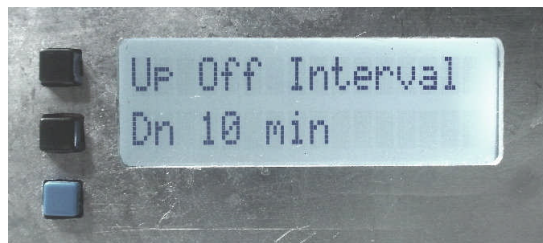


Fig. 16 Off Interval Time

Use the Up and Dn buttons to change the off time. The Off Time can be set between two and fifty-nine minutes in one minute increments. Press Sw3 to enable the off timer and save the off interval.

Off Interval Notes:

1. The off interval does not save seconds, only minutes, so will only be accurate to within one minute. For example if the off interval is set to two minutes the device could turn off anytime between 61 and 120 seconds.
2. Pushing any button will increment the off interval. For example if the off interval is set to 20 minutes, when any button is pushed the off time becomes the time the button was pushed plus 20 minutes.
3. When measuring RF power press Sw1 briefly to increment the off time by the off interval.

Backlight

CleverLoad has 16 user selectable backlight levels changed by varying the duty cycle of an 8 kHz PICAXE PWM output. The user backlight level selection changes the backlight level, and the display shows the PWM duty cycle and the approximate DC supply current that backlight will consume based on previous characterization. To change the backlight level press Sw3 to enter the SL Utilities menus then using the Up Dn buttons navigate to the 'Backlight' menu and press Sw3.

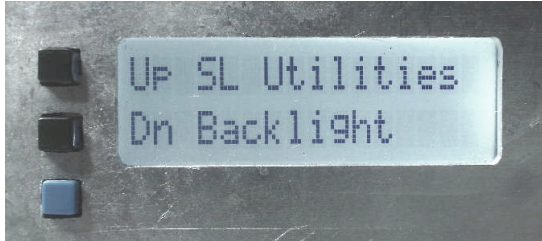


Fig. 17 Backlight Menu

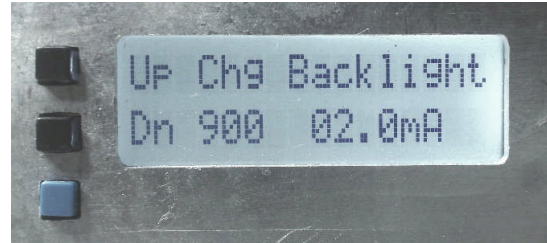


Fig. 18 Backlight Data Display

Initially the screen will show the lowest light level, 999, which consumes about 100uA. Menu selections range from 999 to 001 which consumes about 20mA.

Use the Up Dn buttons to navigate to a suitable level. A good compromise between brightness and current consumption is 950, 1.2mA or 900, 2mA. Either setting will provide good backlight levels in darkened situations.

Press Sw3 to save the backlight choice. The program will automatically go back to measuring RF power.

Temperature Alarm

A thermal sensor is located adjacent to the RF termination resistor. It can be used to control a heatsink fan in higher power units, but in this lower power device it's used to alert the user to the fact that the RF termination resistor is hot so that the RF power level can be reduced. The alarm temperature is user selectable from 30 to 55 deg.C. The sensor is only loosely coupled to the termination resistor temperature. The sensor typically runs 5 to 20 deg.C cooler depending on the duration over which RF power is applied. CleverLoad has significant thermal mass, therefore when the alarm is triggered it can be several to tens of minutes before the unit cools enough to shut off the alarm. A hysteresis of three degrees is built into the software, so the alarm will trigger at the user set temperature and it will cease when the temperature falls three degrees below the user set alarm threshold. Because the alarm duration is typically fairly long and the patience of many users short, an escape has been built in. With the alarm active, pressing Sw3 will take the user back into measuring mode. This of course essentially ignores the alarm. If the escape is used the unit will still perform as usual but no further temperature alarm indication will be invoked until the unit falls below the hysteresis threshold. So user beware! If the unit turns off and is turned back on while the temperature is above the hysteresis threshold the alarm will resume. To set the alarm, bring up the SL Utilities menu by pressing Sw3. Navigate to the 'Temp Alarm' menu.



Fig. 19 Temperature Alarm Menu

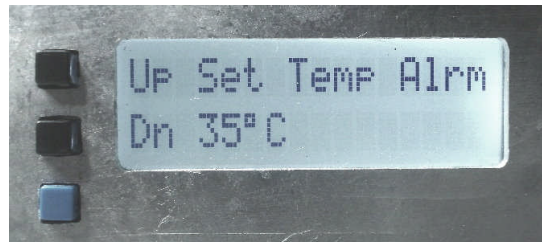


Fig. 20 Set Temp Alarm

Press Sw3 to display the 'Set Temp Alm' submenu. Use the Up & Dn keys to select the alarm threshold temperature. Press Sw3 to save the value and be returned to the RF measuring system.

When the temperature alarm triggers, the display backlight will begin flashing and the display



Fig. 21 Display with Temperature Alarm Triggered

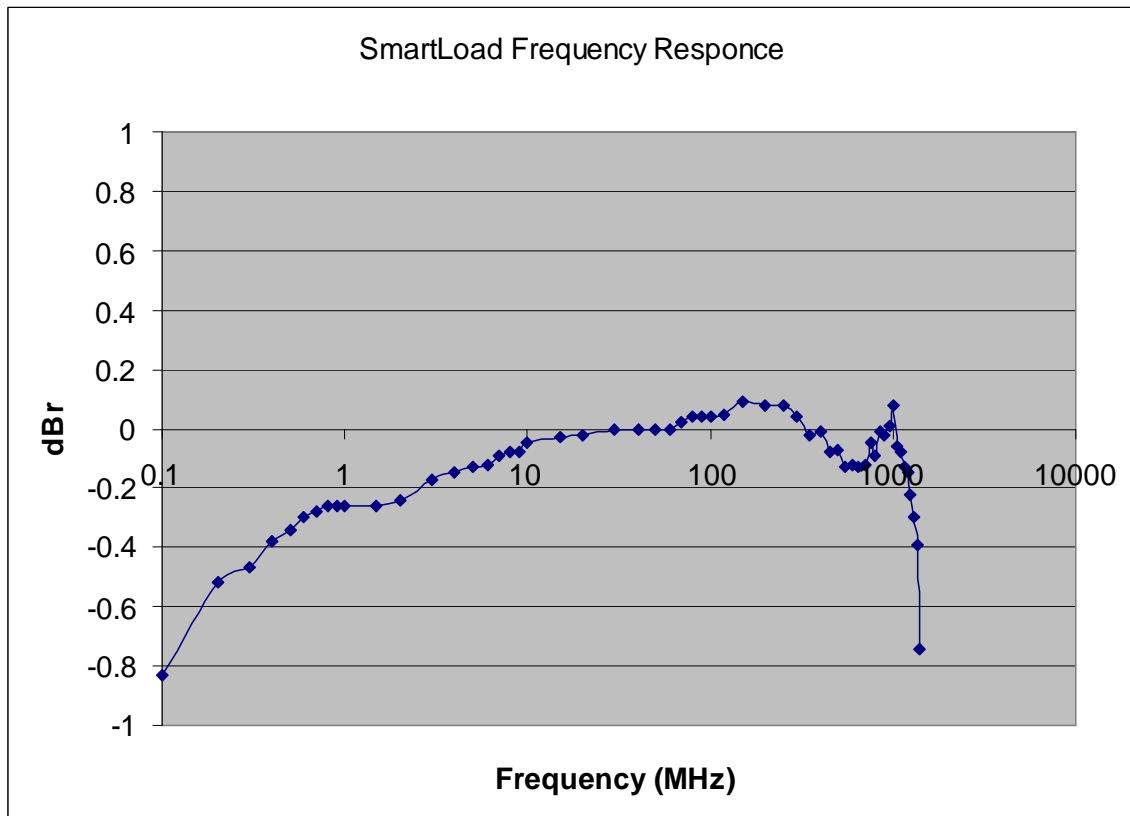
content changes to display HOT! HOT!, the temperature, and the current power being measured. The measured power will show in dBm or Watts depending on the mode selected before the alarm activated. The mode can't be changed for the duration of the alarm. If the RF level is reduced to below -10dBm a LoRf indication replaces the power display.

Power Off

This is the last SL Utilities menu item. Navigate to it by pressing Sw3 to bring up the SL Utilities menu. Press the Dn button to navigate to the Power Off menu item. Press Sw3 again to turn the unit off.

Frequency Response

The frequency response measurement use 50MHz as an arbitrary reference point.



Return Loss

MP930 return loss measurement

