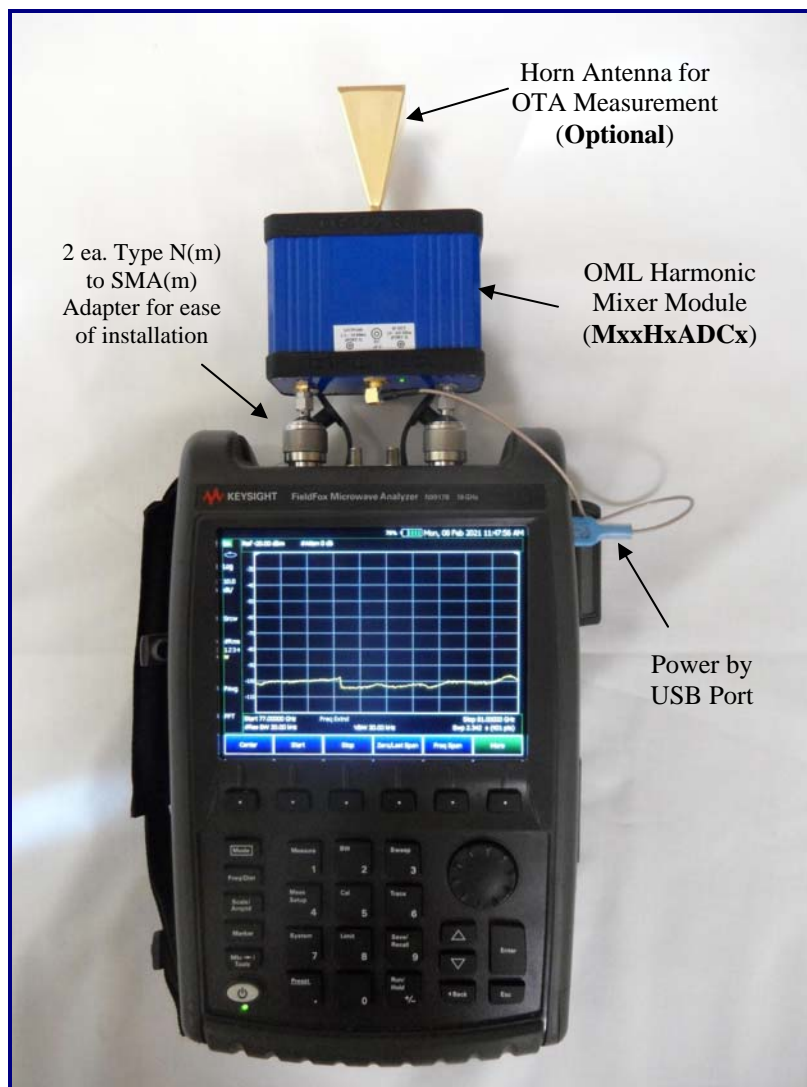




# Harmonic Mixer Module Setup with Keysight FieldFox



OML has developed harmonic mixer frequency extender modules to operate with Keysight FieldFox analyzers. The combination of the two offers a truly portable millimeter wave measurement solution in the field at your fingertips.

This paper presents the setup steps on the FieldFox to allow for portable millimeter wave measurements, anywhere, anytime.

The first section provides setup steps for FieldFox with installed firmware release version A.11.75 (Apr 30, 2020) or higher. The firmware release has embedded OML models, such as M28H2ADC, M15H4ADC, M12H6ADC and M10H6ADC, nominal conversion correction factors and displays the measured results in the RF input frequencies. It is most suitable for a quick evaluation without having to install the individual unique module's correction factors.

The second section setup is independent of FieldFox's firmware release version. The manual setup requires conversion factor file, LO frequency and power to be installed and defined. It has more manual setup steps than the first section before initiating measurement.

All the necessary setup parameters are in each RF block conversion frequency band correction factor file located in the USB flash drive folder named "**Cables**". The composite of all frequency block conversion correction factor files covers the module frequency operating range.

In the "non-direct-connect" configuration, LO power can be adjusted to compensate for cable loss in "Port 1" path. However, compensating for "Port 2" cable loss, if required, can only be accomplished by modifying the uploaded conversion factor file.

The most noticeable difference for this second setup is that the measurement only displays in the frequency block down-converted IF frequency bands. User must convert the measured IF frequency band to RF frequency band.

## “Direct-Connect” Frequency Extender Module to Keysight FieldFox Analyzers

1. Connect Frequency Extender Module LO In port and IF Out port to FieldFox Port 1(RF Output) and Port 2 (SA RF Input), respectively.

**Note:** For ease of connection between FieldFox and Frequency Extender Module ports, it is recommended to use the appropriate adapter for both connector interfaces:

- N(m)/SMA(m) adapter
  - MA(m/f) adapter
  - N(m/f) adapter
  - 2.4mm(f)/SMA(m) adapter
2. Connect Frequency Extender Module DC port to either one of the two FieldFox USB ports using the USB/SMB DC cable provided.

## Configure Keysight FieldFox Analyzers with Embedded Millimeter Wave Bands Firmware Release UI

Applies to FieldFox 18 GHz or higher models with firmware release version A.11.75 or higher

1. Press **ON/OFF** hard key to energize the **FieldFox**.
2. Press **Mode** hard key and press **SA** soft key to load spectrum analyzer application, if applicable.
3. Press **Mode**, **System / 7** hard key and **Utilities** soft key to access frequency extender module function.
4. Press **Freq Extnd** soft key and **Select Freq Extnd Head** soft key to access the built-in frequency extender module selection.
5. Use either the thumbwheel knob or **Up/Down** arrow key to highlight and select the desired factory built-in frequency extender model

- M10H6ADC (75-110G)
- M12H6ADC (60-90G)
- M15H4ADC (50-75G)
- M28H2ADC (24-40G)

6. Press **Recall File** to install factory “**default .csv**” amplitude conversion correction factor file.

For example: Screen monitor displays “Recalled [INTERNAL]:\Converter\M28H2ADC\_Default.csv” to indicate the selected M28H2ADC module conversion correction factor file is being installed.

7. Toggle **Freq Extd / ON OFF** “OFF” position “ON” position to **Freq Extd / ON OFF** to activate frequency extender function.
8. Toggle **App Corr / ON OFF** to **App Corr/ ON OFF** to activate factory default conversion factor amplitude correction, if desired.
9. Press **Freq / Dist** hard key to select the frequency band of interest via “Center” and “Freq Span” or “Start” and “Stop” soft key function. Enter value using numeric keypad and press **GHz** soft key (for value entered in term of GHz) to complete the data entry.

(For example: 5G 28 GHz Band – Center = 27.925 GHz and Span = 0.85 GHz or Fstart = 27.5 GHz and Fstop = 28.35 GHz)

*(Note: Maximum allowed frequency span selection/display is 6 GHz)*

## View/Modify Factory Default Conversion Factor file

1. Press **Mode**, **System / 7** hard key and then **Utilities** soft key to access the frequency extender module function.

(Note: “**Freq Extd**” and “**App Corr**” should be “ON”)

2. Press **Freq Extnd** soft key and toggle **Setup Corr / Auto Edit SA** soft key from “**Auto**” to “**Edit SA**” position **Setup Corr / Auto Edit SA** to access the installed default tabular data table.
3. Press **Scale / Amptd** hard key and then press **More**, **Corrections**, **OML Converter ON** and **Edit Converter** soft key to view or edit factory default correction factor data file.
4. Press **Done** soft key to exit editing mode.

## Install USB Flash Drive Conversion Factor csv file

Each Frequency Extender Module USB flash drive contains measured “converter” conversion factor data that is unique to that Frequency Extender Module. The “converter” conversion factor csv file is located in the USB flash drive labeled “**Converter**” folder.

The “converter” conversion factor csv file contains the LO frequency, LO power level to derive the amplitude conversion factor corrections for given frequency bands, encompassing the frequency extender module operating frequency range.

To install the USB csv file, “**Setup Corr**” must be in the “**Edit SA**” mode **Setup Corr / Auto Edit SA**, **App Corr** and **Freq Extnd** must be in the “**ON**” position, **App Corr / ON OFF**, **Freq Extnd / ON OFF**.

1. Press **Scale / Amptd** hard key and press **More**, **Corrections** & **OML Converter On** soft key to access Converter soft key menu.
2. Press **Storage Device / [Internal]** soft key and press **USB** soft key to define csv file location.
3. Press **Recall Converter** soft key. Use the thumbwheel knob or **Up / Down** arrow key to highlight the csv file and press **Recall File** to upload the file into the FieldFox.
4. Press **Edit Converter** to view or edit correction factor data file and press **Done** soft key to exit editing mode.

***NOTE: CURRENT FIELDFOX FIRMWARE RELEASE A11.75 to A12.02 MAY NOT BE ABLE TO DISPLAY CSV FILE RF FREQUENCIES THAT ARE NOT PART OF THE FACTORY INSTALLED MODELS.***

# Configure Keysight FieldFox without Firmware Release Version Restriction

***THIS PROCEDURE IS APPLICABLE REGARDLESS OF OML FREQUENCY EXTENDER MODELS ARE LISTED IN FIELDFOX “BULIT-IN” MODEL TABLE. HOWEVER, MEASURED DATA CAN ONLY BE DISPLAYED IN THE DOWN-CONVERTED IF FREQUENCIES, NOT IN TERMS OF THE RF INPUT FREQUENCIES.***

The “banded” csv conversion factor correction files are located in the USB flash drive folder labeled “**Cables**”. The “banded” conversion factor files cover standard frequency bands such as the 5G, 802.11ay, collision avoidance LRR/SRR band, E band backhaul and combinations of standard FCC defined frequency band(s). The summation of all “banded” csv files covers the frequency extender module operating frequency range.

Each “banded” conversion factor file contains the LO frequency, LO power level to derive the down converted IF frequencies with associated conversion correction factor values for the given RF input frequencies

FieldFox “**Cable**” file defines **positive value as “loss” and negative value as “gain”**.

## **Install Conversion Factor csv file(s)**

1. Press **ON/OFF** hard key to energize the **FieldFox**.
2. Press **Mode** hard key and press **SA** soft key to load spectrum analyzer application.
3. Press **Scale / Amptd** hard key and then press **More**, **Corrections** & **Cable / Off** soft key to access the upload conversion factor correction csv file function.

(Note: Verify **Apply Corrections / Auto Disabled** is set to “**Auto**” before pressing **Cable / Off** soft key.

Firmware previous to A11.75 may have nomenclature **RcvrSide Cable / Off** instead of **Cable / Off**.

4. Press **Storage Device / [Internal]** soft key and select **USB** to define csv files location.
5. Press **Recall Cable** soft key and use the thumbwheel knob or the **Up / Down** arrow to highlight/select the desired csv file. Press **Recall File** to install the csv file into the FieldFox.

**Note:** It is recommended to save the csv file(s) to the FieldFox internal storage device.

6. Toggle **Cable / Off ON** soft key from “**OFF**” position to “**ON**” position **Cable / Off ON** to activate the “**Cable**” function.

## View or Edit Correction Factor csv File(s)

7. Press **Edit Cable** soft key. Use the thumbwheel knob or **Up / Down** arrow key to view or change correction factor value and press **Done** to exit editing function.

(Note: Frequency column lists the down-converted IF frequencies and Cable Loss column lists the conversion factor associated with each down-converted IF frequency. Positive value = loss and negative value = gain. It is possible to edit the correction factor to compensate Port 2 IF cable loss in the “non-direct connect” configuration).

8. To view graphical representation of the correction factor on the LCD display, press **Scale / Amptd** hard key and then press **More**, **Corrections** and **More** soft key. Toggle **View Corrections / OFF ON** soft key from “OFF” position to “ON” position **View Corrections / OFF ON**.

(Note: A red line representing the correction factor values appears near -60 dBm on the Y-axis. A perfect straight line, before and after the specified frequency span, implies correction factors are linear extrapolated from the last known correction factor value.)

## Configure LO Power Level and Frequency to the Frequency Extender Module

1. Energize the **FieldFox** using the **ON/OFF** hard key, if applicable.
2. Press **Mode** hard key and press **SA** soft key to load spectrum analyzer application, if applicable.
3. Press **Mode** hard key and then **Measure** hard key to access tracking generator/independent source function.
4. Press **Source** soft key to set the CW Source (LO) parameters for the frequency extender module.
5. Press **Source Power -15dBm** soft key and enter **-11\*** using the numeric key pad and press **dBm** soft key to accept the entered value.

*(\*For reference only: See USB flash drive csv file(s) for LO frequency, LO power level and the associated IF frequency band for the frequency band of interest. LO Power can be adjusted to compensate Port 1 LO cable loss in the “non-direct connect” configuration).*

6. Confirm **Source Mode / [CW]** is shown. If not, press **Source Mode / [CW]** and **CW** soft key to set internal source to a single fixed frequency (CW) output..

**Note:** Be sure “tracking offset” function and “offset tracking reversal” function are “off” for FieldFox equipped with tracking generator option by pressing the **Advanced** soft key.

7. Press **Source CW Freq / [3.0000 GHz]** soft key and use the numeric key pad to enter the desired LO frequency [FieldFox Port 1 (RF Output)] found in the csv file. Press **GHz** to accept the entered value.
8. Toggle **Source Enable / OFF ON** soft key from “OFF” to **Source Enable / OFF ON** to “ON” to activate the internal source with the new input parameters.

## **Configure IF Display Frequency Range**

1. Press **Freq / Dist** hard key and set the start and stop IF frequency using the **Start** and **Stop** soft key to the specified IF frequency range in the csv file of interest. Press **GHz** to accept the entered value.

**Measured data beyond the specified IF frequency limits will be less accurate.**

**Do not assign “start” and “stop” IF frequency beyond module spec limit of 0.3 GHz and 6.5 GHz.**

**Changing the IF frequency “Start”, “Stop” or “Center” and “Freq Span” represent viewing different RF Input frequency range. Maximum RF frequency range is limited by the specified IF frequency range for the given csv file.**

**The relationship between RF, LO, IF and n (harmonic number) is expressed in the following equation**

$$\mathbf{RF = n \times LO + IF}$$

## **Capture Swept Signals (Optional)**

1. Press **Mode** hard key and then **Trace** hard key to access screen display function.
2. Press **State [Clr / Wr]** soft key and select **MaxHold** or any of the options shown.



## Save Setup (.STA File)

Save setup is recommended to avoid having to repeat the same setup procedure in the future.

1. Press **Mode** hard key and then press **Save / Recall** soft key to activate save feature.
2. Confirm **File Type / [Trace+State]** is shown. If not, press **File Type / [xxxxxx]** and **[Trace+State]** soft key.
3. Confirm **Device / [Internal]** is shown. If not, press **Device / [xxxxxx]** and **[Internal]** soft key.
4. Press **Save** soft key, enter the save file name and then press **Done** soft key to save the file.

## Recall .STA Setup File(s)

1. Press the **ON / OFF** hard key to energize the **FieldFox**, if necessary.
2. Press **Mode** hard key and then press **Save / Recall** soft key to activate recall feature.
3. Confirm **Device / [Internal]** and **File Type / [Trace+State]** are shown. If not, make the appropriate change to reflect the file storage device and file type.
4. Press **Recall** soft key and use either the **Up / Down** arrow key or thumbwheel knob to select the filename.sta file.
5. Press **Run / Hold** hard key to release the ‘Hold’ feature to the frequency sweep function. Alternate method is to press **Mode**, **Sweep** hard key and then either **Restart** soft key or toggle **Continuous / OFF ON** soft key.

## Recall USB Flash Drive Furnished “Banded” Setup .STA File(s)

Each .STA file in the USB flash drive is “plug n’ play” ready, if furnished. However, conversion factor corrections and LO (CW Source) power are typical values and may not necessary be the values in the selected csv file.

**It is important to verify and/or change CW Source power level and/or install the conversion factor csv files that are in the “Cables” folder to improve the overall amplitude accuracy.**

1. Press the **ON / OFF** hard key to energize the **FieldFox**, if necessary.
2. Press **Mode** hard key and press **Save / Recall** soft key to activate save feature.
3. Confirm **Device / [USB]** and **File Type / [Trace+State]** are shown. If not, make the appropriate change to reflect the file storage device and file type.  
(Note: There should be equal numbers of csv files in the “**Cables**” folder as are STA files in the USB Flash drive root directory.)
4. Press **Recall** soft key and use either the **Up / Down** arrow key or the thumbwheel knob to select the filename.sta file.
5. Press **Run / Hold** hard key to release the ‘Hold’ feature to the frequency sweep function.
6. See “**Configure LO Power Level and Frequency to the Frequency Extender Module**” section to verify/change the LO (CW) power level.
7. See “**Install “Banded” Conversion Factor csv File(s)**” section to install “banded” conversion factor correction file.
8. Save the updated setup STA file by following steps in “**Save Setup (.STA File)**” section, if desired.

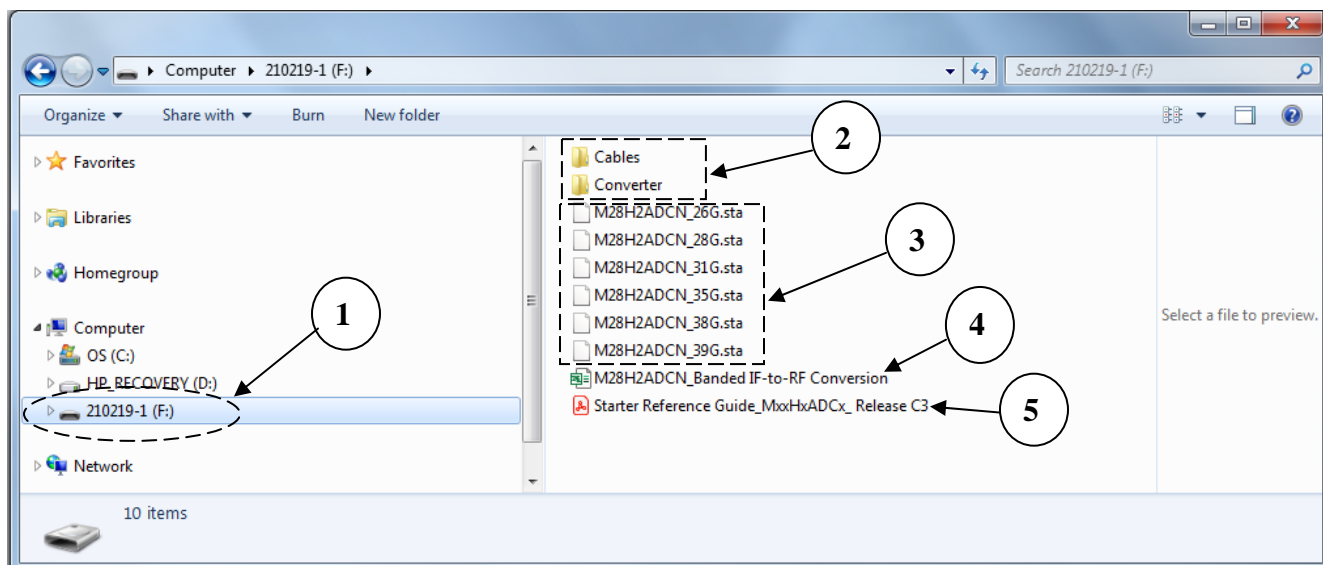
## USB Flash Drive Contents

The following describes the USB flash drive contents supplied with each OML frequency extender module (MxxNxADCx) as of February 01, 2021.

1. USB flash drive identification is the same as the module's serial number.
2. There are two (2) folders in the USB flash drive – Cables and Converter.
  - “Cables” folder csv files are designed for “Banded” conversion factor file setup procedure
  - “Converter” folder csv file is intended to replace FieldFox embedded “default” file, if needed.
3. Plug n’ Play” ready “Banded” Trace + State files. These files circumvent the need for manual setup procedure as described in “Configure Keysight FieldFox Analyzers with “Banded” Conversion Factor File”.

Refer to “Recall USB Flash Drive Furnished “Banded” Setup .STA File” section to familiar with the furnished setup .sta files.

4. Rudimentary Excel workbook illustrates the conversion of measured IF frequencies to the RF input frequencies in the "Banded" Conversion Setup measurements.  
(Note: This Excel spreadsheet may not be available for all OML models).
5. Starter Reference Guide.



## “Cables” Folder Contents

These “banded” conversion factor csv files are intended for “Configure Keysight FieldFox Analyzers with “Banded” Conversion Factor File” setup. The “Banded” conversion factor csv files are applicable to modules with the same model number and serial number as csv file.

Multiple “banded” csv files covering module’s operating frequency range (i.e., 24 GHz to 40 GHz for M28H2ADCN). Each banded csv file cover only the specified frequency range.

Example of 28 GHz band covering 27.5 to 28.35 GHz

Amplitude Correction

Field	Value
28GBand (27.5-28.35GHz)	Frequency band definition and frequency range coverage
M28H2ADCN S/N 210219-1	Model/Serial Number & Test Date
Date: 2-3-2021	
LO=12.3125 GHz @ -12dBm	LO frequency and power level to achieve the down conversion factor.
IF = 2.875-3.725 GHz	Down convert IF frequency band from RF frequency range of 27.5 GHz to 28.35 GHz. Each file contains 201 data points.
Converted RF frequency range to IF frequency range	IF = RF- n x LO
[DATA]	FieldFox “Cables” loss amplitude value definition
2.875	-9.36
2.87925	-9.4
2.8835	-9.5
2.88775	-9.49

Positive value indicates loss and negative value indicates gain

## “Converter” Folder Contents

This conversion factor csv file is designed for modules with the same model number and serial number shown on the csv file. It is intended to replace FieldFox factory installed “default.csv” to enhance amplitude measurement accuracy or to provide conversion factor correction for models without factory “default.csv” file.

Embedded single csv file covering module's operating frequency range (i.e., 24 GHz to 40 GHz for M28H2ADCN)

Model/Serial Number & Test Date

Essential frequency bands required to cover module's operating frequency range. Each band uses different LO frequency for the down conversion. Same LO power level for each band is used to derive the conversion factors. There are 201 conversion factor data points per band.

FieldFox “Converter” amplitude value definition  
Positive value indicates gain and negative value indicates loss

Frequency GHz	Conversion dB
24	5.64
24.0175	5.55
24.035	5.46