

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
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Overview

This document describes the Prelevel adjustment via GPIB commands, following the procedure specified in the HP8648 Operating and Service Guide Manual.

The Agilent Service Software will generate slope (gain) and offset calibration data, which will be saved to A6 Output module EEPROM. The adjustment is performed on next frequencies: 1002, 1100, 1200, 1300...up to 2000MHz for B version (11 points), 3200MHz for C version (23 points) or 4000MHz for D version (31 points). The prelevel detector is located prior Frequency Extension ALC modulator input, therefore prelevel calibration ensure adequate flat level for FE ALC operation above 1000MHz.

Prelevel array contains 32 points and the empty fields are filled by gain/offset values corresponding with last frequency.

Reference Instructions

Prelevel (8648B/C/D Only)

Description

This adjustment creates the slope and offset calibration data for the preleveler calibration.

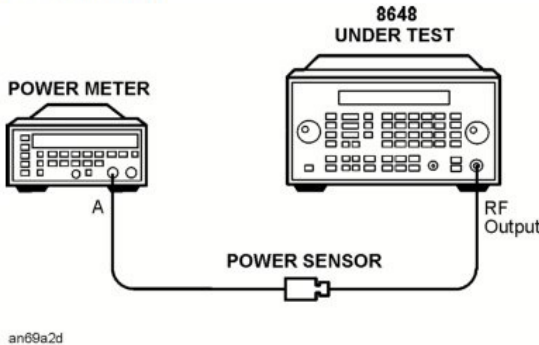
The adjustment will not let you store away any calibration data unless all of the calibration data points are run.

Required Test Equipment

- Power Meter
- Power Sensor

Procedure

Figure 7-18. Prelevel Test Setup



1. Connect the equipment as shown above.
2. Preset all of the equipment.
3. Follow the instructions as they are displayed on the PC.

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
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GPIB sequence according to Agilent Service Support Software (partial sequence)

```

SERV:PRODUCTION:PUP
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
FREQ 100.0000000000 MHZ
POWER:ATT:AUTO 1
POWER:AMPL -136.0000000000
AM:STATE 0
FM:STATE 0
PM:STATE 0
OUTPUT 1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
POWER:AMPL 0.0000000000
IP
LG
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09

FREQ 1002.0000000000 MHZ
KB95.000000EN
*OPT?
HIGH STABILITY REF,0,HIGH POWER,0,0,0,
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H00
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #Hfff
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H2c3
TR2
CS@18
+16.210E+00
TR2
+16.200E+00
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H1f5
TR2
CS@18
+13.150E+00
TR2

```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
-----------------------------	-------------	---------------

+13.140E+00

```
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
```

```
FREQ 1100.0000000000 MHZ
KB95.000000EN
*OPT?
HIGH STABILITY REF,0,HIGH POWER,0,0,0,
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H00
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #Hfff
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H2c3
TR2
CS@18
+16.420E+00
TR2
+16.440E+00
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H1f5
TR2
CS@18
+13.400E+00
TR2
+13.400E+00
```

```
...
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
-----------------------------	-------------	---------------

```
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
```

```
FREQ 2000.0000000000 MHZ
KB95.000000EN
*OPT?
HIGH STABILITY REF,0,HIGH POWER,0,0,0,
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H00
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #Hfff
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H2c3
TR2
CS@18
+15.490E+00
TR2
+15.490E+00
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H2e0
TR2
CS@18
+15.610E+00
TR2
+15.620E+00
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H1f5
TR2
CS@18
+12.910E+00
TR2
+12.880E+00
```

```
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
```

```
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL out_lvl_gain,0,339.800000000 //1002MHz
SERV:PRODUCTION:CAL out_lvl_gain,1,332.300000000
SERV:PRODUCTION:CAL out_lvl_gain,2,300.600000000
```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
-----------------------------	-------------	---------------

```

SERV:PRODUCTION:CAL out_lvl_gain,3,305.1000000000
SERV:PRODUCTION:CAL out_lvl_gain,4,281.1000000000
SERV:PRODUCTION:CAL out_lvl_gain,5,343.5000000000
SERV:PRODUCTION:CAL out_lvl_gain,6,306.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,7,328.6000000000
SERV:PRODUCTION:CAL out_lvl_gain,8,304.5000000000
SERV:PRODUCTION:CAL out_lvl_gain,9,365.7000000000
SERV:PRODUCTION:CAL out_lvl_gain,10,454.8000000000 //2000MHz
SERV:PRODUCTION:CAL out_lvl_gain,11,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,12,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,13,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,14,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,15,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,16,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,17,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,18,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,19,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,20,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,21,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,22,454.8000000000 //3200MHz
SERV:PRODUCTION:CAL out_lvl_gain,23,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,24,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,25,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,26,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,27,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,28,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,29,454.8000000000
SERV:PRODUCTION:CAL out_lvl_gain,30,454.8000000000 //4000MHz
SERV:PRODUCTION:CAL out_lvl_gain,31,454.8000000000
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE Outlvl_data
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL out_lvl_ofs,0,13.2210000000 //1002MHz
SERV:PRODUCTION:CAL out_lvl_ofs,1,9.4920000000
SERV:PRODUCTION:CAL out_lvl_ofs,2,24.9850000000
SERV:PRODUCTION:CAL out_lvl_ofs,3,10.3760000000
SERV:PRODUCTION:CAL out_lvl_ofs,4,24.7440000000
SERV:PRODUCTION:CAL out_lvl_ofs,5,-14.7960000000
SERV:PRODUCTION:CAL out_lvl_ofs,6,2.3330000000
SERV:PRODUCTION:CAL out_lvl_ofs,7,-27.3580000000
SERV:PRODUCTION:CAL out_lvl_ofs,8,-23.1130000000
SERV:PRODUCTION:CAL out_lvl_ofs,9,-80.0440000000
SERV:PRODUCTION:CAL out_lvl_ofs,10,-132.6070000000 //2000MHz
SERV:PRODUCTION:CAL out_lvl_ofs,11,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,12,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,13,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,14,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,15,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,16,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,17,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,18,-132.6070000000

```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
-----------------------------	-------------	---------------

```

SERV:PRODUCTION:CAL out_lvl_ofs,19,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,20,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,21,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,22,-132.6070000000 //3200MHz
SERV:PRODUCTION:CAL out_lvl_ofs,23,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,24,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,25,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,26,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,27,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,28,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,29,-132.6070000000
SERV:PRODUCTION:CAL out_lvl_ofs,30,-132.6070000000 //4000MHz
SERV:PRODUCTION:CAL out_lvl_ofs,31,-132.6070000000
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE Outlvl_data
SERV:PRODUCTION:CAL:STORE OUT_TUNE_CAL
SERV:PRODUCTION:PUP

```

Procedure Overview

1. Initial Hookup Summary

Calibrate the HP438A power meter. Connect the power sensor to HP8648 output. Set power meter via GPIB to logarithmic mode, calibration factor and read actual output power by triggering:

```

IP          // Unknown command
LG          //Log (dBm)
KB95.000000EN //Cal Factor
TR2        //Trigger with Delay
CS@18     //Clear status byte

```

Output setup to 0dBm, CW mode:

```

POWER:ATT:AUTO 1
AM:STATE 0
FM:STATE 0
PM:STATE 0
OUTPUT 1
POWER:AMPL 0.0000000000

```

Next GPIB commands will disable FE ALC and set FE DAC to #H1f4 (500 dec). Are used before and after every frequency point. Unknown purpose, maybe to avoid ALC instability during frequency switching.

```

DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #H1f4
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H00

```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
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Set frequency 1002MHz, the 1st calibration point: `FREQ 1002.0000000000 MHZ`

Set A10 Frequency Extension module DAC to #Hfff (4095 dec), FE ALC loop enabled, reset reverse power protection (RPP) module:

```
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H00
```

```
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #Hfff
```

```
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H01
```

```
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H01
```

Set A6 Output module DAC to #H2c3 (707 dec) and read output power:

```
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H2c3
```

Set DAC to obtain +13dBm (+/-0.4), adjust DAC value up/down:

```
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H1f5
```

For example, next set of values will be obtained: #H2c3 / 16.2dBm, #H1f5 / 13.14dBm. Based on these values, the calibration gain & offset will be calculated.

Set frequency to 1100MHz, the 2nd calibration point and repeat above procedure. Repeat for every 100MHz steps up to 2000MHz.

2. Prelevel above 2GHz (HP8648C/D)

If HP8648 maximum frequency cover above 2GHz, continue with same calibration procedure but different A6 DAC value and output target:

```
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H00
DIAG:LATCH:SELECT "freq_ext_level_DAC"
DIAG:LATCH:VAL #Hfff
DIAG:LATCH:SELECT "fext_ALC_state"
DIAG:LATCH:VAL #H01
DIAG:LATCH:SELECT "atten_4GHz_rpp_reset"
DIAG:LATCH:VAL #H01
```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
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Set frequency to 2100MHz, the 12th calibration point: `FREQ 2100.0000000000` MHZ
 Set A6 Output module DAC to #H276 (630 dec) and read output power:

```
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H276
```

Set DAC to obtain +12dBm (+/-0.4), adjust DAC value up/down:

```
DIAG:LATCH:SELECT "out_carrier_level_DAC"
DIAG:LATCH:VAL #H1f5
```

Repeat for every 100MHz step up to maximum HP8648's frequency range.

4. Gain and Offset calculation

DAC Gain / Offset values for every frequency point are calculated by Agilent Service Software. Unfortunately, the formula used to generate these 2 constants is still unknown. The algorithm is based on:

Up to 2GHz:

DAC #H2c3 (707 dec) and RF output power obtained.
 DAC value required for +13dBm output.

Above to 2GHz:

DAC #H276 (630 dec) and RF output power obtained.
 DAC value required for +12dBm output.

5. Calibration saving to EEPROM

```
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL out_lvl_gain,0,339.8000000000
...
SERV:PRODUCTION:CAL out_lvl_gain,31,454.8000000000
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE Outlvl_data

SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL out_lvl_ofs,0,13.2210000000
...
SERV:PRODUCTION:CAL out_lvl_ofs,31,-132.6070000000
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE Outlvl_data
SERV:PRODUCTION:CAL:STORE OUT_TUNE_CAL //do not use it, read remarks section
```

6. Instrument reboot

```
SERV:PRODUCTION:PUP
```

Adjustment: Prelevel	HP8648B/C/D	YO4HFU – v1.0
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Remarks

The prelevel adjustment routine is used to calibrate the gain and offset of the A6 Output DAC. The algorithm initially sets the DAC to a predefined value (707 <2GHz or 630 >2GHz). The resulting RF output power is then measured and used as a reference point.

Based on this reference measurement, the target DAC value is estimated and fine-adjusted to achieve the specific output level of approx. +13dBm below 2GHz or +12dBm above 2GHz.

The calibration is performed at 100MHz frequency intervals, starting at 1002MHz (e.g., 1002, 1100, 1200, etc). During the calibration process, the Frequency Extension (FE) module DAC is set to its maximum value (4095), FE ALC loop enabled.

The resulting calibration constants, “out_lvl_gain” and “out_lvl_ofs”, are stored in the A6 EEPROM using the “Outlvl_data” command syntax. Can be noted that Agilent software use also “OUT_TUNE_CAL” syntax which is a bug. This command must be used exclusively to store tracking filter DAC values and not for prelevel.

Unfortunately, the formula used to calculate the gain / offset parameters is deep embedded within the Agilent Service Support Software and remains undocumented.

Below are several data samples obtained for frequencies below 2GHz that may help understanding of the gain and offset calculation. The A6 Output DAC has a 12-bit resolution (4095).

Index	DAC Hex value (Dec)	Output Level (dBm)	Gain	Offset
1	H2c3 (707)	16.2	339.8	13.221
	H1f5 (501)	13.15		
2	H2c3 (707)	16.42	332.3	9.492
	H1f5 (501)	13.4		
3	H2c3 (707)	17.04	300.6	24.985
	H1cf (463)	13.27		
4	H2c3 (707)	17.1	305.1	10.376
	H1c9 (457)	13.32		
5	H2c3 (707)	17.54	281.1	24.744
	H1b9 (441)	13.42		
6	H2c3 (707)	16.45	343.5	-14.796
	H1e0 (48)	13.15		
7	H2c3 (707)	17.12	306.8	2.333
	H1c5 (453)	13.36		

Target DAC can be calculated using:

$$DAC_{target} = DAC_{ref} * 10^{[P_{target} - Pref]/20}$$

Example:

DAC_{ref} = 707, Pref = 16.2, P_{target} = 13

$$DAC_{target} = 707 * 10^{[13 - 16.2]/20} = 489 \text{ (H1e9), close to 501 (H1f5).}$$

73's de Robert YO4HFU