Adjustment: Motherboard Audio Path	HP8648A/B/C/D	YO4HFU – v1.0

Overview

This document describes the procedure to calibrate the Motherboard Audio Path by GPIB, following the procedure specified in the HP8648 Operating and Service Guide Manual.
The calibration process is extensive, particularly due to the complexity of the required GPIB.

Next fields will be calibrated:
MOD_FM_1KHZ, MOD_FM_400HZ, MOD_FM_EXTDC, MOD_FM_EXTAC
MOD_PM_1KHZ, MOD_PM_400HZ, MOD_PM_EXTDC, MOD_PM_EXTAC

Each FM/PM test includes 4 sub-tests: Normal 0dB / Normal -20dB / Inverted 0dB / Inverted -20dB

MOD_AM_1KHZ, MOD_AM_400HZ, MOD_AM_EXTDC, MOD_AM_EXTAC
Each AM test includes 2 sub-tests: Normal 0dB / Normal -20dB

Total: 40 fields to calibrate.

Reference Instructions

Motherboard Audio Path (All 8648A/B/C/D)

This adjustment calibrates the internal and external audio paths of the motherboard by determining the full-scale (100%) DAC values required for the audio path calibration.

For internal modulation measurements, the DAC is set to a percentage, DAC Offset Percentage, of its value. The percentage is 70% for the 8648A and 90% for the 8648B/C/D. At each DAC value, the corresponding output depth/deviation is measured with the measuring receiver and the slope of the DAC is calculated using the following:

$$\text{Slope} = \frac{(\text{Measured Depth})/(\text{Deviation})}{\left(\frac{\text{DAC Offset Percentage}}{100}\right) \times 4095}$$

The slope determines the actual value of the DAC required to set the modulation level at the exact DAC Offset Percentage. The DAC is fine-tuned by measuring the output depth/deviation and adjusting the DAC until the resulting depth/deviation is within a specified tolerance. The final value of the DAC for internal modulation measurements is calculated as follows:

$$\text{DAC Value}_{int} = \frac{\text{DAC Value at DAC Offset Percentage}}{\left(\frac{\text{DAC Offset Percentage}}{100}\right)}$$

The difference between internal and external modulation involves compensating for the inaccuracies of the external function generator. First, the voltage level of the function generator is set to 1.083 volts (not 1V) to compensate for the mismatch between its 600 ohm output and the 50 ohm input of the DUT. Then, the actual voltage is measured and the target deviation set at DAC Offset percentage of the measured voltage. The level DAC is adjusted for DAC Offset Percentage deviation and then the 100% level DAC value for external modulation measurements is calculated as shown:

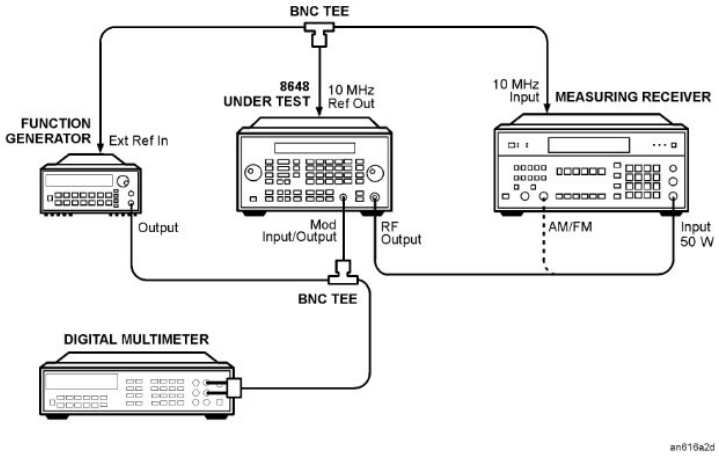
$$\text{DAC Value}_{ext} = \frac{\text{DAC Value at DAC Offset Percentage}}{\text{Actual 3325B Voltage} \times \left(\frac{\text{DAC Offset Percentage}}{100}\right)}$$

Required Test Equipment

- Function Generator
- DVM
- Measuring Receiver

Procedure

Figure 7-23. Motherboard Audio Path 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.

GPIB sequence according to Agilent Service Support Software (simulated values, only AM & store routines are shown, see attached .txt for full code)

*** // additional comment

```
RESET
FUNC ACV
RANGE 30
NDIG 3
SERV:PRODUCTION:PUP
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
FREQ 100.0000000000 MHZ
POWER:ATT:AUTO 1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
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
*rst
APPL:SIN
FREQ 1000.000000 // Function Generator 1KHz
VOLT 1.083000  // Function Generator Output
41. SP
```

```
RANGE 3
TRIG SGL
1.00000+00    // DVM monitoring voltage on MOD INT
TRIG SGL
1.00000+00
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
41. SP
M1
D1
8.1SP*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
FREQ 100.0000000000 MHZ
POWER:ATT:AUTO 1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
POWER:AMPL -136.0000000000
AM:STATE 0
FM:STATE 0
PM:STATE 0
OUTPUT 1
FM:STATE 0
PM:STATE 0
AM:STATE 1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
POWER:AMPL 4.0000000000
OUTPUT 1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
FREQ 750.0000000000 MHZ
750.000000 MZ
AM:SOURCE INT
AM:INT:FREQ 1000
L2 //Modulation Monitor LPF 15KHz
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 100.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+0000000900E-01
T0
+0000000900E-01
D2
T0
+0000000900E-01
T0
+0000000900E-01
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H613
D1
T0
+0000000700E-01nT0
```

```
+0000000700E-01nD2
T0
+0000000700E-01n
T0
+0000000700E-01n
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 10.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+000000900E-02
T0
+000000900E-02
D2
T0
+000000900E-02
T0
+000000900E-02
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H613
D1
T0
+000000700E-02
T0
+000000700E-02
D2
T0
+000000700E-02
T0
+000000700E-02
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*OPT?
0,0,HIGH POWER,0,0,0,
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*OPT?
0,0,HIGH POWER,0,0,0,
L1
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*OPT?
0,0,HIGH POWER,0,0,0,
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:SOURCE INT
AM:INT:FREQ 400
L1  //Modulation Monitor LPF 3KHz
*IDN?
```

```
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 100.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+0000000900E-01
T0
+0000000900E-01
D2
T0
+0000000900E-01
T0
+0000000900E-01
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H613
D1
T0
+0000000701E-01
T0
+0000000701E-01
D2
T0
+0000000701E-01
T0
+0000000701E-01
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*OPT?
0,0,HIGH POWER,0,0,0,
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 10.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+000000900E-02
T0
+000000900E-02
D2
T0
+000000900E-02
T0
+000000900E-02
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H613
D1
T0
+000000699E-02
T0
+000000699E-02
D2
T0
+000000699E-02
```

```
T0
+000000699E-02
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 100.0000000000
AM:SOURCE EXT
AM:EXT:COUP DC
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+0000000850E-01
T0
+0000000850E-01
D2
T0
+0000000850E-01
T0
+0000000850E-01
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H919
D1
T0
+0000000990E-01
T0
+0000000990E-01
D2
T0
+0000000990E-01
T0
+0000000990E-01
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 10.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+000000850E-02
T0
+000000850E-02
D2
T0
+000000850E-02
T0
+000000850E-02
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H919
D1
T0
+000000994E-02
T0
+000000994E-02
```

```
D2
T0
+000000994E-02
T0
+000000994E-02
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 100.0000000000
AM:SOURCE EXT
AM:EXT:COUP AC
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+0000000850E-01
T0
+0000000850E-01
D2
T0
+0000000850E-01
T0
+0000000850E-01
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H919
D1
T0
+0000000992E-01
T0
+0000000992E-01
D2
T0
+0000000992E-01
T0
+0000000992E-01
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
AM:DEPTH 10.0000000000
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H7d0
D1
T0
+000000850E-02
T0
+000000850E-02
D2
T0
+000000850E-02
T0
+000000850E-02
DIAG:LATCH:SELECT "modist_mod_range_DAC"
DIAG:LATCH:VAL #H919
D1
T0
```

```
+000000989E-02
T0
+000000989E-02
D2
T0
+000000989E-02
T0
+000000989E-02
*IDN?
Hewlett-Packard, 8648B, 3847A02762, B.04.09
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_FM_1KHZ,0,2221.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_FM_1KHZ,1,2221.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_FM_1KHZ,2,2221.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_FM_1KHZ,3,2498.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_FM_400HZ,0,2352.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_FM_400HZ,1,2352.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_FM_400HZ,2,2438.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_FM_400HZ,3,2438.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_FM_EXTDC,0,3534.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_FM_EXTDC,1,3534.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_FM_EXTDC,2,3534.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_FM_EXTDC,3,3327.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_FM_EXTAC,0,3534.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_FM_EXTAC,1,3534.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_FM_EXTAC,2,3534.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_FM_EXTAC,3,2977.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_PM_1KHZ,0,2221.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_PM_1KHZ,1,2221.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_PM_1KHZ,2,2352.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_PM_1KHZ,3,2221.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_PM_400HZ,0,2498.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_PM_400HZ,1,2221.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_PM_400HZ,2,2498.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_PM_400HZ,3,2221.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_PM_EXTDC,0,3327.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_PM_EXTDC,1,3327.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_PM_EXTDC,2,3327.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_PM_EXTDC,3,3448.0000000000 //  -20dB, Inverted
```

```
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_PM_EXTAC,0,3407.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_PM_EXTAC,1,3327.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL MOD_PM_EXTAC,2,3534.0000000000 //  0dB, Inverted
SERV:PRODUCTION:CAL MOD_PM_EXTAC,3,3250.0000000000 //  -20dB, Inverted
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_AM_1KHZ,0,2221.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_AM_1KHZ,1,2221.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_AM_400HZ,0,2221.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_AM_400HZ,1,2221.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_AM_EXTDC,0,3327.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_AM_EXTDC,1,3327.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_AM_EXTAC,0,3327.0000000000 //  0dB, Normal
SERV:PRODUCTION:CAL MOD_AM_EXTAC,1,3327.0000000000 //  -20dB, Normal
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
SERV:PRODUCTION:PUP
*rst
RESET
```

Procedure Overview

Setup Function Generator (HP33120A): 1KHz sine, 1.083V / 50Ω, used for external AC or DC coupled test.
Setup Measuring Receiver (HP8902A):
FM mode: HPF 50Hz for 400Hz tone, HPF 300Hz for 1KHz tone, LPF 3KHz, Trigger with Settling, PEAK+, PEAK-
PM mode: HPF 50Hz for 400Hz tone, HPF 300Hz for 1KHz tone, LPF 3KHz, Trigger with Settling, PEAK+, PEAK-
AM mode: LPF 3KHz for 400Hz tone, LPF 15KHz for 1KHz tone, Trigger OFF , PEAK+, PEAK-

During External AC/DC coupled calibration, the function generator is set to output 1.083 V, Zout = 50 Ω. Since the MOD INPUT connector of the HP8648 has an impedance of 600 Ω, the voltage at the input will be approximately 1 V.
A DVM is connected to monitor this level, sending the voltage value so that the algorithm can perform a calibration correction. For simplicity, it is assumed that the signal amplitude at the MOD INPUT is exactly 1.0000 V / sine 1 KHz.

Otherwise, the target deviation (or depth) is corrected by multiplying it by the measured voltage.

The service manual is not very clear. Additionally, the statement "The percentage is *70% for the HP8648A and 90% for the HP8648B/C/D*" appears to be incorrect. According to the Agilent Service Software results, all models use 70%.

I. FM Calibration

Set the DAC to #H7d0 (2000) and read the resulting deviation. Calculate the slope to estimate the DAC value for the target deviation. Fine-tune the DAC as needed until the measured deviation matches the target.
Slope = Deviation / DAC value; DAC target = Target deviation / Slope.

Target deviation for Internal 0dB = ±70.0KHz (±0.3) and -20dB = ±7.00KHz (±0.03)
Target deviation for External 0dB = ±99.0KHz (±0.4) and -20dB = ±9.90KHz (±0.04)

Calculate calibration value: CAL = (DAC value x Scale) / 70
Scale: 100 for 0dB and 10 for -20dB.

1. MOD_FM_1KHz:

Mode	Frequency	Source	Deviation	Level Mod.	Polarity
FM	750.000 MHz	Internal 1KHz	100.0 kHz	0 dB	Normal
FM	750.000 MHz	Internal 1KHz	10.0 kHz	-20 dB	Normal
FM	100.000 MHz	Internal 1KHz	100.0 kHz	0 dB	Inverted
FM	100.000 MHz	Internal 1KHz	10.0 kHz	-20 dB	Inverted

2. MOD_FM_400Hz has same procedure as MOD_FM_1KHz. Source Internal 400Hz.

3. MOD_FM_EXTDC:

Mode	Frequency	Source	Deviation	Level Mod.	Polarity
FM	750.000 MHz	External DC	100.0 kHz	0 dB	Normal
FM	750.000 MHz	External DC	10.0 kHz	-20 dB	Normal
FM	100.000 MHz	External DC	100.0 kHz	0 dB	Inverted
FM	100.000 MHz	External DC	10.0 kHz	-20 dB	Inverted

4. MOD_FM_ EXTAC has same procedure as MOD_FM_EXTDC. Source External AC coupled.

II. PM Calibration

Set the DAC to #H7d0 (2000) and read the resulting deviation. Calculate the slope to estimate the DAC value for the target deviation. Fine-tune the DAC as needed until the measured deviation matches the target.
Slope = Deviation / DAC value; DAC target = Target deviation / Slope.

Target deviation for Internal 0dB = ±7.00rad (±0.03) and -20dB = ±0.700rad (±0.003)
Target deviation for External 0dB = ±9.90rad (±0.04) and -20dB = ±0.990rad (±0.004)

Calculate calibration value: CAL = (DAC value x Scale) / 70
Scale: 10 for 0dB and 1 for -20dB.

5. MOD_PM_1KHz:

Mode	Frequency	Source	Deviation	Level Mod.	Polarity
PM	750.000 MHz	Internal 1KHz	10.0 rad	0 dB	Normal
PM	750.000 MHz	Internal 1KHz	1.00 rad	-20 dB	Normal
PM	100.000 MHz	Internal 1KHz	10.0 rad	0 dB	Inverted
PM	100.000 MHz	Internal 1KHz	1.00 rad	-20 dB	Inverted

6. MOD_PM_400Hz has same procedure as MOD_PM_1KHz. Source Internal 400Hz.

7. MOD_PM_EXTDC:

Mode	Frequency	Source	Deviation	Level Mod.	Polarity
FM	750.000 MHz	External DC	10.0 rad	0 dB	Normal
FM	750.000 MHz	External DC	1.00 rad	-20 dB	Normal
FM	100.000 MHz	External DC	10.0 rad	0 dB	Inverted
FM	100.000 MHz	External DC	1.00 rad	-20 dB	Inverted

8. MOD_PM_ EXTAC has same procedure as MOD_PM_ EXTAC. Source External AC coupled.

III. AM Calibration

Set the DAC to #H7d0 (2000) and read the resulting depth. Calculate the slope to estimate the DAC value for the target depth. Fine-tune the DAC as needed until the measured depth matches the target.
Slope = Depth / DAC value; DAC target = Target depth / Slope.

Target depth for Internal 0dB = 70.0% (±0.3) and -20dB = 7.00% (±0.03)

Target depth for External 0dB = 99.0% (±0.4) and -20dB = 9.90% (±0.04)

Calculate calibration value: CAL = (DAC value x Scale) / 70
Scale: 100 for 0dB and 10 for -20dB.

9. MOD_AM_1KHz:

Mode	Frequency	Source	Depth	Level Mod.	Polarity
AM	750.000 MHz	Internal 1KHz	100.0%	0 dB	Normal
AM	750.000 MHz	Internal 1KHz	10.00%	-20 dB	Normal

10. MOD_AM_400Hz has same procedure as MOD_AM_1KHz. Source Internal 400Hz.

11. MOD_PM_EXTDC:

Mode	Frequency	Source	Depth	Level Mod.	Polarity
AM	750.000 MHz	External DC	100.0%	0 dB	Normal
AM	750.000 MHz	External DC	10.00%	-20 dB	Normal

12. MOD_AM_ EXTAC has same procedure as MOD_PM_EXTDC. Source External AC coupled.

Remarks

As a side note, the high-cost HP3458A DVM, HP33120A Function Generator, Monitor Receiver HP8902A are the only instruments supported by Agilent Service Software. For example, HP34401A DVM is not compatible, as it uses different SCPI commands. GPIB emulation of the HP3458A and HP8902A was necessary to enable the Service Software to operate correctly (dummy instruments), utilizing AR488 interfaces and custom sketch.

The calibration procedure looks complex but can be simplified. DAC slope determination is **not** required, it will be replaced by manual adjustment. Just as info:

Slope = Deviation / DAC value;

DAC target = Target deviation / Slope.

Example: *Slope* = 90KHz / 2000 (h7d0) =>0.045; *DAC target* = 70KHz / 0.045 => 1555 (h613)

Calibration example

Let's suppose we want to calibrate the MOD_FM_1KHZ, 0 dB, Normal. First we check the MOD_FM_1KHz table to find the required settings.

1. **Setup HP8648:** FM mode, Internal 1 kHz, 100 kHz deviation, 750 MHz, RF out +4 dBm

2. **Setup modulation meter:** FM mode, HPF 300Hz, LPF 3KHz, (+Peak – Peak) / 2

3. **Access modulation level DAC via GPIB command:**
`DIAG:LATCH:SELECT "modist_mod_range_DAC"`, then adjust the value to obtain the target deviation ±70.0 kHz (±0.3) on the modulation monitor.

Adjust DAC value by `DIAG:LATCH:VAL #H9AA`, the hex value is H9AA, equivalent to 2474 decimal. DAC value just must be between 2100 and 4000; otherwise, the calibration is considered a "Fail" according Agilent Service Software (a DAC value outside the valid range may indicate a hardware malfunction).

4. Calculate calibration constant:
CAL = (DAC value x Scale) / 70
CAL = (2474 x 100) / 70 = 3534 => value required to store inside EEPROM

5. Store calibration constant to motherboard EEPROM:
For Normal mode, 0dB, the index CAL MOD_FM_1KHz is 0.

Index for RAM/EEPROM store	Level	Polarity
0	0 db	Normal
1	-20dB	Normal
2	0 db	Inverted
3	-20dB	Inverted

Level: 0dB for full nominal deviation (100KHz), -20dB for 1/10 of nominal deviation (10KHz).
Polarity: Normal mode tested at 750MHz and Inverted mode at 100MHz

```
SERV:PRODUCTION:CAL:BEGIN
SERV:PRODUCTION:CAL MOD_FM_1KHZ,0,3534
SERV:PRODUCTION:CAL:END
SERV:PRODUCTION:CAL:STORE mod_dac
```

For "External AC/DC coupled" calibrations, the input amplitude should be 1.0000 V / 1 kHz sine measured at the MOD INPUT connector. Otherwise the target modulation value must be multiplied by voltage value.

6. Reboot HP8648:
`SERV:PRODUCTION:PUP`

I hope this document clarifies the procedure for calibrating the HP8648's modulation path.

73's de Robert YO4HFU