Quick Start Guide: Isomet iMS Studio

Isomet iMS Studio v1.3.0.xxx is a Windows graphic user interface for the iMS4- series of 4 channel synthesizers and supplied with the SDK. Please check web site support page for latest revision (June 2023 SBK = v 1.8.8)

This guide gives a brief description of the iMS4 functions, how to use the Isomet GUI and concludes with several examples.

[Note: This guide assumes individual file sizes < 1024 frequency data points. The iMS4-P is capable of storing >10 million points however the GUI will react slowly for Image files exceeding ~2000 points. Please contact Isomet for guidance on using the GUI for large image sizes]

The current release of GUI does not support the following SDK features:

- Diagnostics
- Image Play Sequences

(All these features are supported in the SDK for C++).

Download the appropriate installation program from: http://www.isomet.com/software.html

Uninstall any previous versions of the SDK and/or GUI

Depending on your computer select and run one of the following :

Isomet iMS SDK v 1.8.x Win7 Setup.exe

Isomet iMS SDK v 1.8.x Win10 Setup.exe

Follow the installation instructions.

NOTE: We are aware that some 64-bit PC's will not install the 64-bit Isomet iMS SDK.
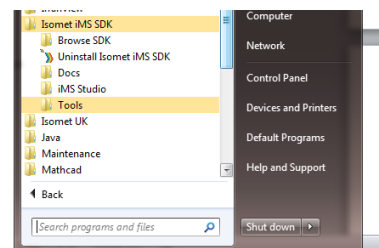In this case, please install the 32-bit version.

A full explanation and supporting SDK documentation is found under:

a, Start menu > All Programs > Isomet iMS SDK

b, GUI tool bar, *About* menu

c, from the installed folder
  …>> Program Files / Isomet / iMS_SDK / v1.8.x / doc

Run: *Isomet iMS Studio*.

- **Communication**

At DC power on, all LEDs on the iMS4-P will illuminate during an initialization phase that includes reading EEPROMs, initializing peripherals, powering up the USB controller and requesting DHCP IP address from a connected Ethernet Server. If the DHCP request times out after ~10sec , the iMS reverts to a static IP address.

After this period, the upper red LED's will remain illuminated and two green LED's will beat at ~1Hz rate

It is recommended that USB or Ethernet are connected to the iMS4- prior to power up.
We recommend attempting USB communication AFTER initialization is complete.

iMS Library versions 1.4 (and onwards) will allow Ethernet or USB connection using the Isomet GUI and Microsoft Visual Studio software.

NOTE: If the GUI is not closed correctly, crashes or will not open, then please use Windows Task Manager to delete the *Isomet iMS Studio* and *ims_hw_server* processes. Then restart GUI.
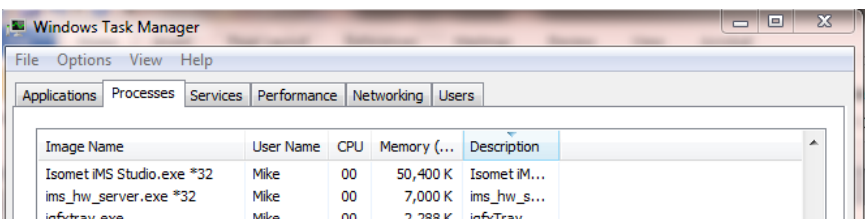
Ethernet (iMS4-P-):
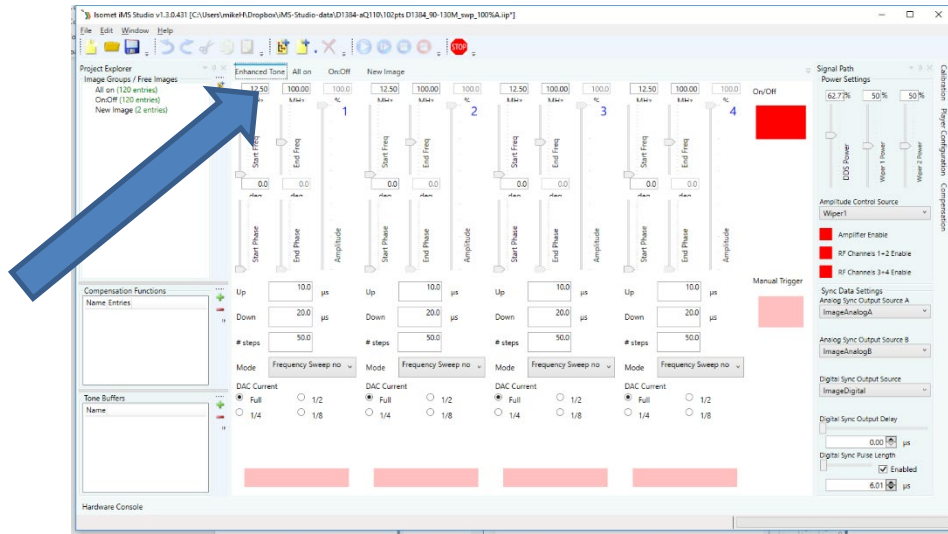The default static IP address for the iMS4 is 192.168.1.10.
This can be set to another value by the user through the SDK
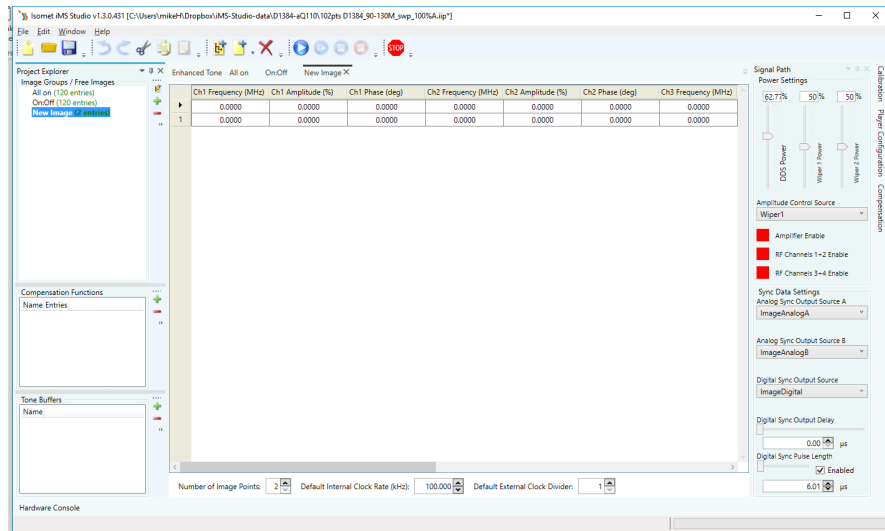You may need to disable other Ethernet adaptors to avoid a contention.

Overview: GUI Windows and tabs

Opening window

Depending on the selected page either the *Enhanced Tone* mode or *New Image* panel will be displayed

If the *New Image* panel is selected, the default page will look similar to

The central window is the main input array. This behaves much like a typical spread sheet.
- Copy and paste can be applied to individual cells, cell groups, entire rows or columns.
- Rows can be deleted or inserted.

The array is used to input the Frequency, Amplitude , Phase, and Synchronous output data.
The column data is predefined and differs depending on the selected operating mode.

A brief description of the available operating modes is presented below followed by an example for each.

Tone buffer(s) mode
One or more tables of 256 frequencies/amplitude/phase* (F/A/P) values.
- Columns display the Frequency, Amplitude and Phase values.
  This is repeated for each of the 4 channels.
- Rows display the buffer entry. Up to 256 max lines per buffer.
- Frequency dependent Phase/Amplitude compensation look up table (LUT) may be applied.

Array values can be entered directly into the GUI array or copied from an Excel spread sheet.

Image files (s) mode
One or more files containing many frequencies/amplitude/phase*/sync data points.
- Columns display the Frequency, Amplitude and Phase values PLUS a 12bit wide digital output register and two synchronous output DACs.
  The F/A/P data is repeated for each of the 4 channels.
- Rows display the image point entry.
- Frequency dependent Phase/Amplitude compensation look up table (LUT) may be applied.

Image mode is useful for generating larger more complex frequency scan patterns.
Values can be entered directly into the GUI array or data copied from an Excel spread sheet.

In both modes, selected cells within a column can be inserted, deleted, auto filled or interpolated.
Left click mouse to select a start cell, shift-left click mouse to select an end cell.
Right click mouse to reveal options menu for the highlighted cells.

*Phase values are typically applied via the compensation LUT and not in the data entry fields.

Enhanced tone mode (Ramp / Step mode)
This mode uses the inherent sweep functions built into the DDS chip.
Frequency, amplitude** or phase can be ramped in value. For conciseness, only frequency ramps and steps will be described.

- **Ramp Mode**

A ramp or chirp is generated by rapidly incrementing the frequency. The number of increment steps and duration of the ramp are user programmable. Each output can be programmed with different ramp parameters.

The ramps are initiated from the GUI or applying a signal to the external Profile inputs on connector J8
Available functions:
- Independent Up - Down ramp slopes.
- Dwell (stop at end value) or no-dwell (return to start value) at end of sweep duration.
- Set amplitude value for ramp. (remains constant for the ramp duration).

The Ramp mode offers the fastest frequency sweep capability, with a minimum dwell time of 8nsec per frequency increment.

Independent sliders for each of the four output channels define:
- Duration of the rising slope increment.
- Duration of the falling slope increment.
- The number of points for each ramp, up or down.

The falling slope only applies if 'Dwell' is selected in the **Mode** pull down menu.

A **Frequency Sweep no dwell** immediately returns to the start value after the end value has been reached

A ***No-Dwell*** sweep immediately returns to the ***Start*** slider value (S0) after the ***End*** slider value (E0) has been reached
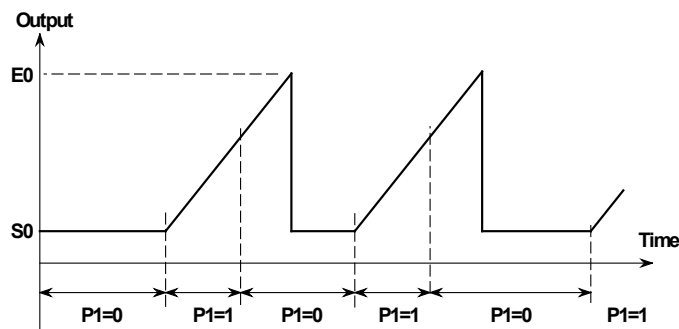
A **Frequency Sweep Dwell** only returns to the start value after a falling edge transition on the appropriate profile input

A ***Dwell*** sweep only returns to the ***Start*** slider value (S0) after a falling edge transition on the appropriate profile input
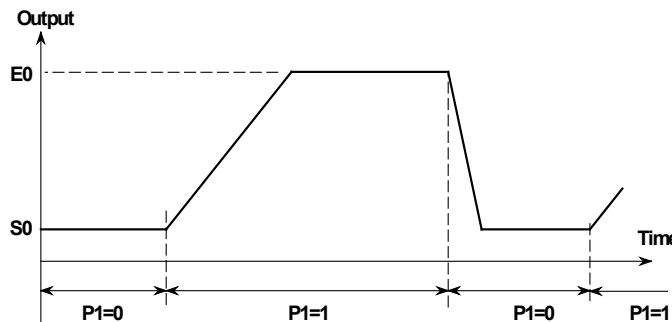
Both plots show a ramp on output J2, controlled using input P1

(**An internal limitation in the DDS chip prevents amplitude ramps in the Enhanced tone mode).

- **Step mode**

This is essentially a two-level sweep or two-level modulation.
Step mode may be applied to the Frequency, Amplitude or Phase.
Dwell/No dwell has no function.

Plot shows a frequency
step sweep for output J2
controlled using input P1.
FREQ = Start Value
CW1 = End Value
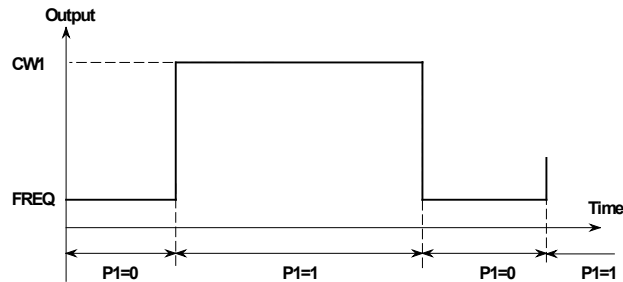
- Amplitude

The amplitude level across a Frequency or Phase sweep (or step) remains a constant.
The value is set by a combination of the **DAC Current** level buttons (Full , ½, ¼, ⅛) and the sliders on the
Signal Path panel.

1: *Signal Path* **tab**

Main purpose this tab is to set the RF power limits and enable RF power amplifier(s) that are connected to the control outputs of the iMS4 (connector J5) .

Overview: Output Power control
Simplified block diagram of a typical iMS4-
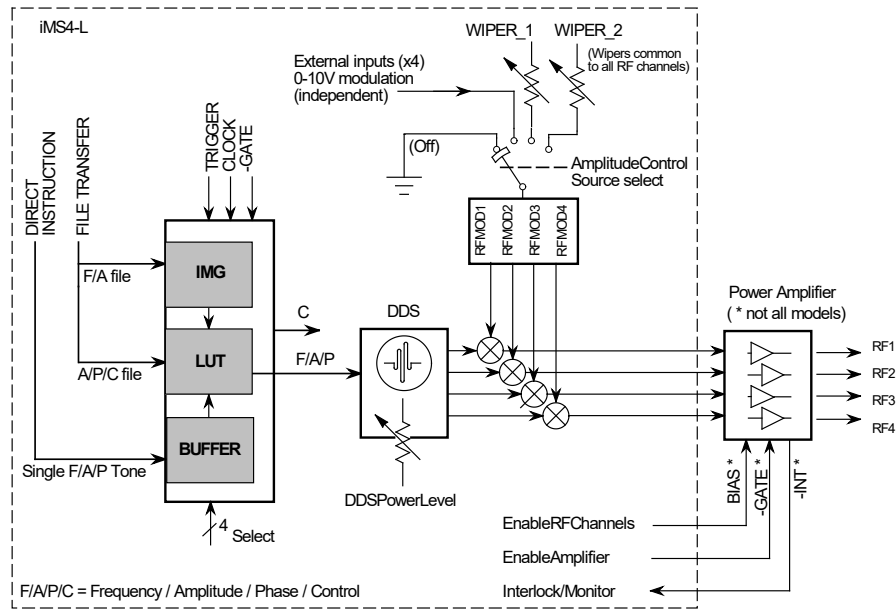
Conceptual diagram for iMS4-L with PA

The output RF power is determined by the <u>combination of three</u> parameters
All three amplitude values should have non-zero values, as described in sections 1.1, 1.2 and 1.3 below.

1.1 Frequency and Channel specific 10-bit Amplitude data.
   Specified Amplitude % value for each frequency point in the **Image File** or **Tone Buffer**.

This value is multiplied by a compensation factor stored in a calibration look up table (LUT).

The LUT can be bypassed if required.
The LUT is applied by default.

7

1.2: **Global control: DDS Power Level.**

8-bit non-volatile digital pot.

GUI slider control is provided
in the *Signal Path* tab
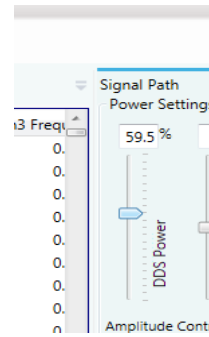
As a general rule, start with a value of 50% or less

Approximate full-scale control 10:1

1.3: **Output RF mixers, proportional amplitude control**.

The control signal for the mixers is selectable; internally generated using the Channel slider controls or by an externally applied input(s) on J7.
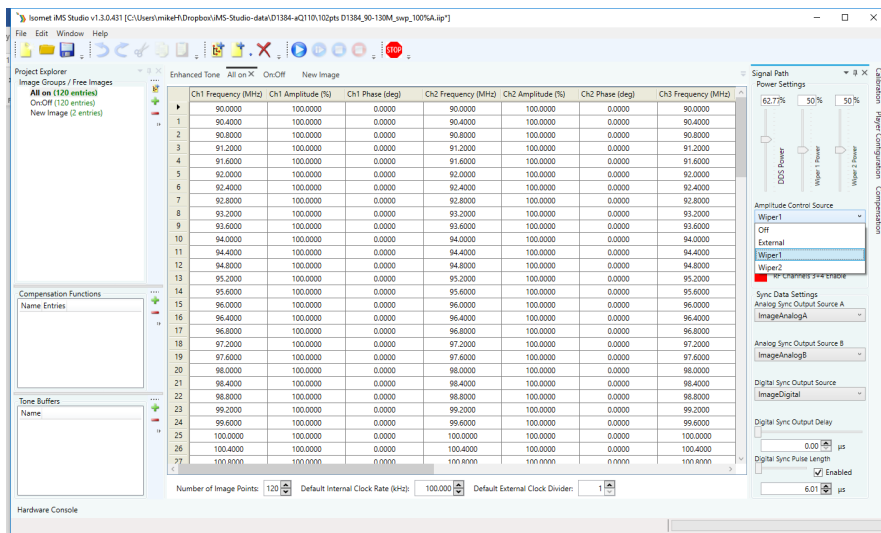
Selection and slider options are provided under the *Signal Path* tab

(Rev-B) Typical selection is Wiper-1, which is an 8-bit non-volatile digital pot with GUI slider control

Approximate full-scale control 1000:1
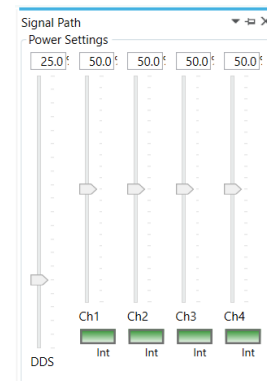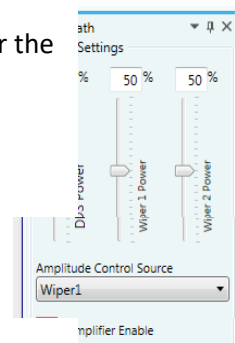
Rev-C , Rev-D features channels scoped control Ch1…4
(See right hand pane)
Range equivalent to Rev-B Wiper-1

The optimum slider settings will depend on the connected RF power amplifier and AO device. Recommended values will be provided on the AO test data sheet supplied with the iMS4-

Sliders values will increment/decrement in steps of 0.1 by using the up-down arrow keys

In a typical system, the iMS4- will be the frequency source to a power amplifier(s). This in turn is connected to the AO modulator, frequency shifter , deflector or tuneable filter.

1.4:   **Amplifier Enable controls**

Depending on the amplifier model connected to the iMS4-, an *Amplifier enable* ("Gate" signal) and PA *RF Channel Enable* signal will be required to turn on the external power amplifier(s).

Toggle Buttons, as shown
Turn Green when active
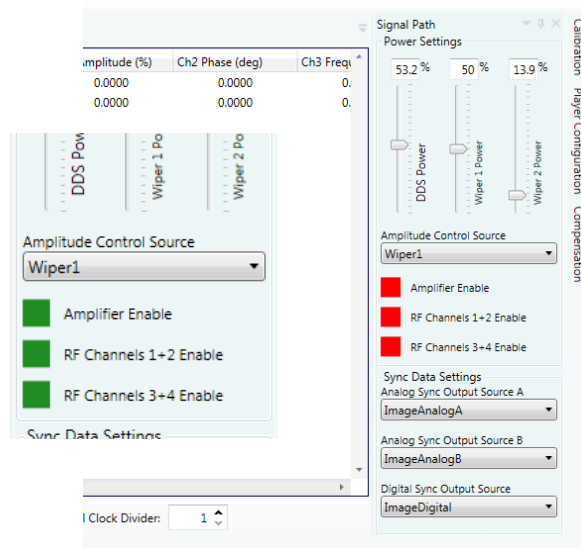
Examples of when to apply:

Connected PA model	Amplifier Enable	RF Channel 1+2	RF Channel 3+4
500C- series	✘	✘	✘
RFA0110- series	✔	✘	✘
RFA0120- series	✔	✘	✘
RFA200-2 series	✔	✘	✘
RFA1170-4- series	✔	✔	✔

2: *Compensation* **tab**

A calibration or compensation look-up-table (LUT) contains frequency specific phase and amplitude data. It may be applied to Image and Tone Buffer frequency points in order to :

a: to compensate for amplitude non-linearities

b: apply a predefined phase shift between adjacent RF channels *.

* For beam steered AO deflectors with multiple RF inputs, a frequency dependent phase shift "steers" the acoustic column in the crystal. This optimizes the Bragg angle relationship resulting in higher efficiency across the scan angle. (see App Note "Beam Steered AO Deflectors")

- LUT values are AO device specific.
- New LUT tables can be generated within the Isomet GUI.

Refer app note *Compensation LUT Table Generation in Isomet GUI*

Step 1: Import the desired LUT table
A graphic representation of the selected LUT data will appear in the panel.
Use the radio buttons to view a plot of the amplitude, phase or sync data
(Right click mouse over plot axis to zoom)

Step 2: DOWNLOAD into iMS4
Download will abort if there is no iMS4 is connected.

- **Channel Scope**

iMS4 hardware rev-C / rev-D permits multiple compensation LUTs. These may be applied to selected channel(s) or channel pairs. Prior revisions only permit the *Global* LUT option i.e. one LUT for all 4 channels.

- **XY AOD (Dual Axis Deflectors)**

If a single iMS4- is driving X-Y AO deflector, check the "*Sync Phase Pairs*" box
In this case, the same compensation LUT will apply to both the X and Y axis
Channel 1 and Channel 3 will both be at zero phase.
Channel 2 will have a phase offset relative to Channel 1 (e.g. X-axis)
Channel 4 will have a phase offset relative to Channel 3 (e.g. Y-axis)

3:      *Calibration* tab (Single Tone output)

This mode does not use the input array.
Values are controlled using the sliders.
The same frequency , amplitude and phase increment are applied across all channels
(Channel 1 is always zero phase)

Use this mode to check basic iMS4 operation and initial AO device alignment or create a compensation LUT.

Click **Calibration** tab on right side toolbar
Adjust sliders to the desired value.

Use with caution.

The Slider limits are fixed and may exceed the range of any connected power amplifier and AO device.
The Compensation LUT values are bypassed.

Click the large RED button to activate . This will change to Green (arrowed).
Click again to disable. It will toggle back to RED.
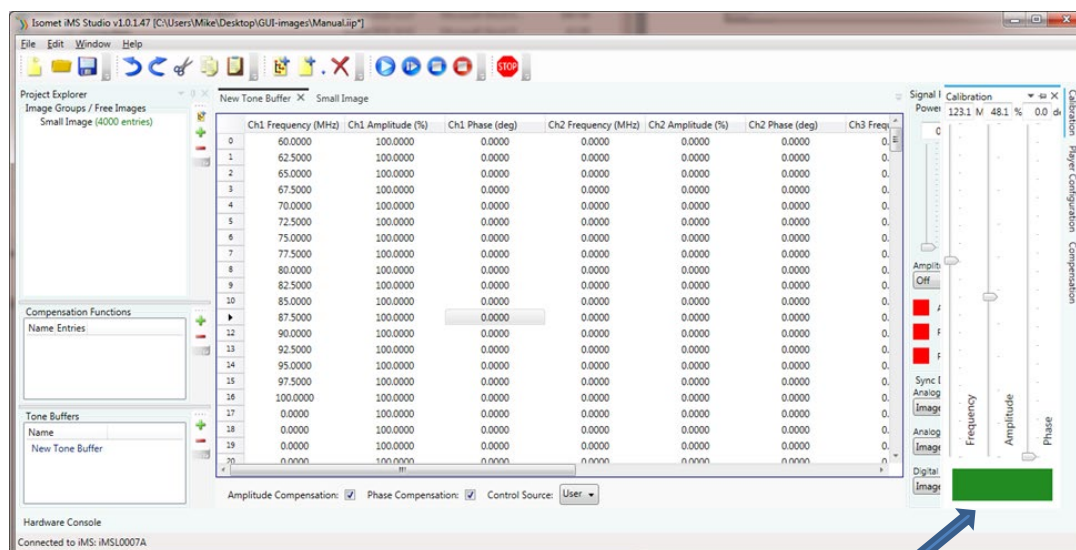
4: *Player Configuration* tab

These functions apply to the Image File output.

e.g.   Choice of Trigger and Clock Source.
          Select the active edge for external clock and/or trigger.
          Action at the end of the Image play.

Check boxes allow selective disabling of the Image mode LUT compensation.
WHEN UNCHECKED:
- Image point amplitude values are multiplied by 100%
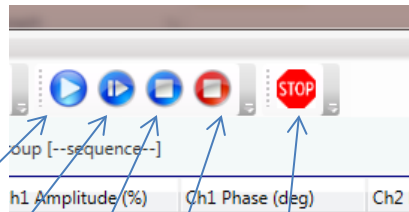- Phase offset = 0 deg all frequencies, all channels.

WHEN CHECKED:
- Image point amplitudes are multiplied by the corresponding value in the compensation LUT.
- Phase value is set according by the corresponding value in the compensation LUT.
(See section 2)
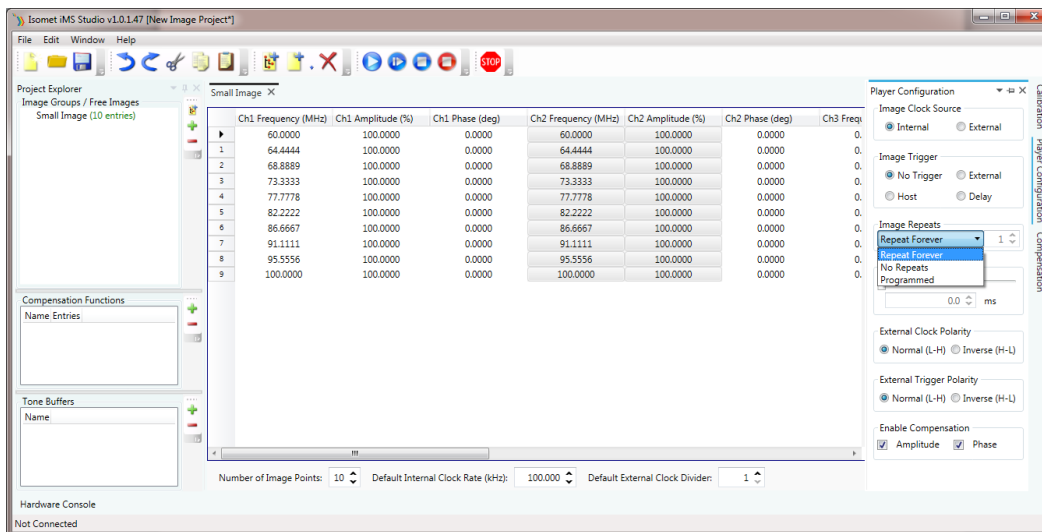
5:   Image Play control

Tool bar buttons

To Start image play

(Reserved for future use)

Stop at end of current Image play

Stop immediately

Emergency Stop, reducing RF power controls to Zero %
and disabling any connected power amps

The lower left tool bar along the bottom of the GUI window will indicate the current state.
e.g. Stopped , Playing Image, Not connected

Note:

PLEASE ALLOW time for the GUI to respond.

Click on **Hardware Console** banner at foot of GUI window to review the messages between the host and iMS4-.

Example 1: Image Mode
To create an Image, follow steps 1: to 4:
To load an existing Image file, go to step 5:

1:        Create a 10-point Image

Example specs:

        10-point image on all Channels (Ch1, Ch2, Ch3 and Ch4).
        Linear frequency scan : 60-100MHz (or choose different values according to your AO device)
        100% amplitude
        Compensation LUT applied
        Synchronous output at mid-scan point, data = 255
        Internal Clock, No trigger, Repeated continuous output
        iMS4 only. No connected power amps.

Enter Number of Image Points (rev-B window shown)
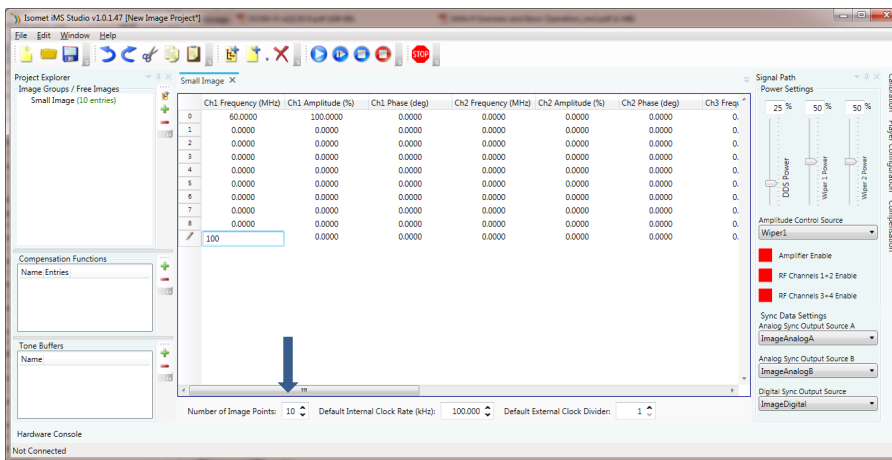
2:        Input Channel1 frequency end points
        Point 0, input 60.00 MHz,   Point 9, input 100.00 MHz
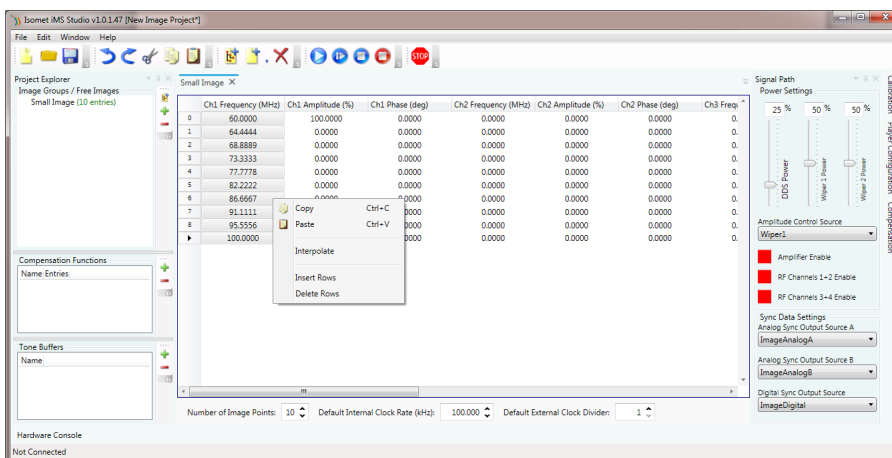
Click on the column header to highlight the cells and right click to reveal the options window.
Choose *Interpolate* to auto fill incrementing values between the start and end point frequencies.

3:      Input Channel1 Amplitude

Click on the column header to highlight the amplitude cells.
Enter 100. A 100% value will auto fill down all highlighted cells.
Navigate away from the amplitude column to complete
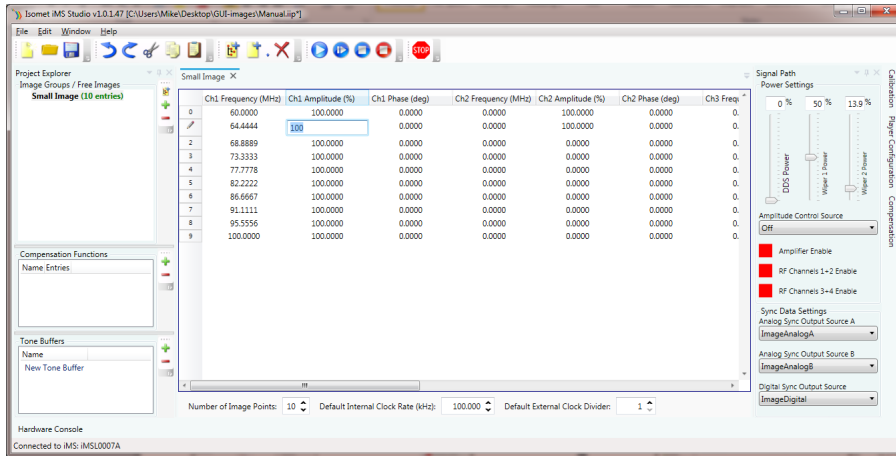
4:      Copy to Channel 2

Left click cell: Channel1_Frequency_Row 0 to select and highlight
Navigate to cell: Channel1_Amplitude_Row 9.   Shift- left click this cell.
This will select the Frequency and Amplitude data for Channel 1

Copy & Paste into Channel 2
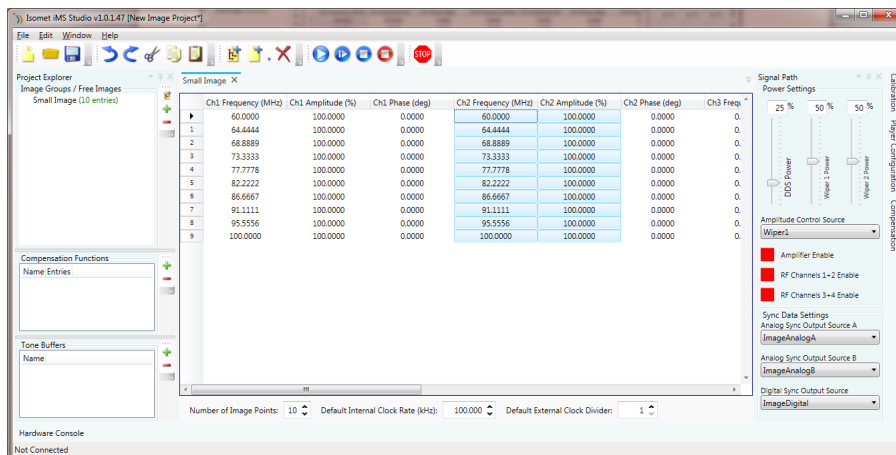
Repeat to copy into Channel 3 and Channel 4.

Go to step 6, Apply Compensation table

5:          Import an existing Image File2

From top tool bar, select *File > Open*
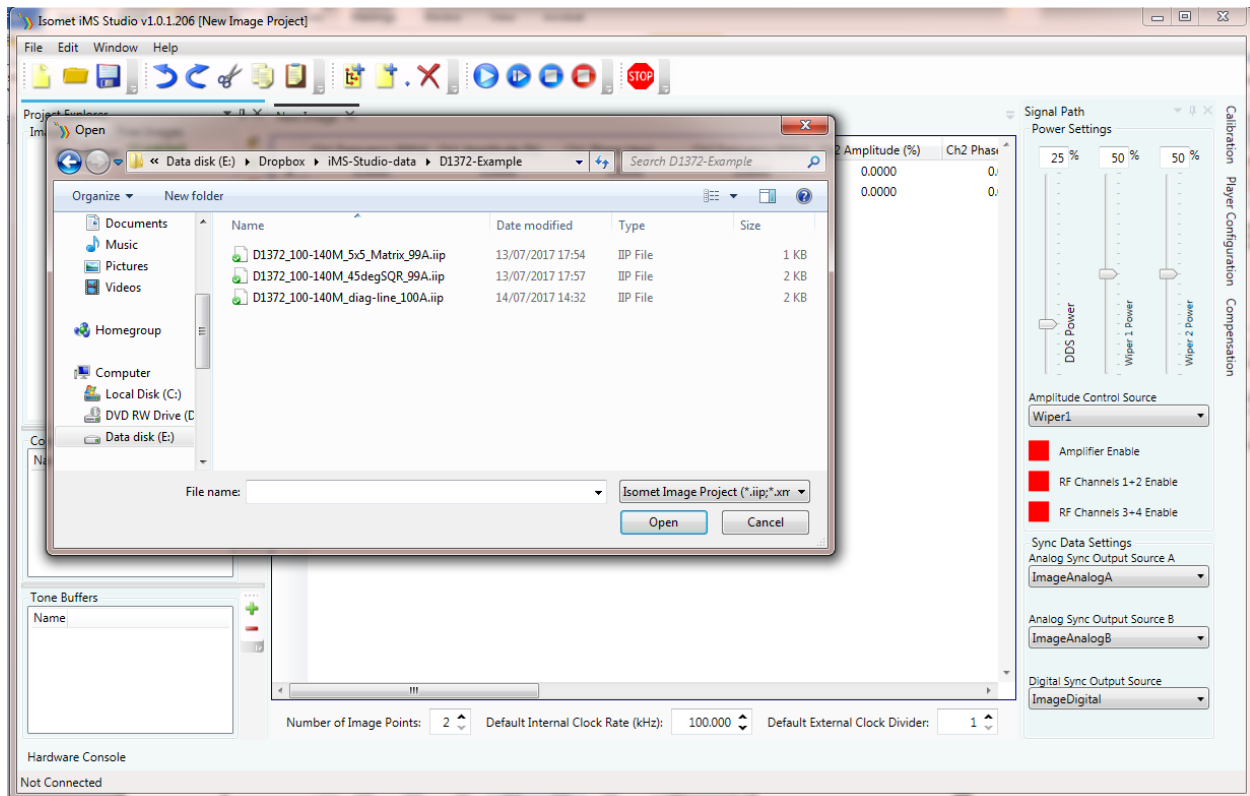
Select the desired *.ipp file

Press **Open**

6: Apply Compensation table

- **IMPORT** the desired LUT table. This will depend on AO deflector model.
- **DOWNLOAD** into iMS4

7: (If desired) Set Synchronous digital output (outputs through connecter J7)

Use the lower slider to navigate to the **Sync Data Dig** column. Input the 12-bit hex coded data at the desired cell(s) locations.(In example screen shot below, 0x001 - 0x000 in alternate cells throughout)
Note: the opto-isolated J7 connector output(s) are inverted with respect to this Sync Data.

Ensure **Digital Sync Output Source** field is set to **ImageDigital**

[Note for iMS4-**L** users. Sync data can only be applied via the Compensation LUT.
In this case, the Digital Sync Output Source is set to **LookUpFieldCh1**]

- **Digital Sync Output Delay and Pulse Length**

By default the **Digital Sync Output Delay** = 0 and *Pulse Length* control is disabled

See scope traces.

Trace 1 (blue) is an RF output. The iMS4- is running
in Image mode at 100KHz clock rate.
Alternate points are programmed with
50% amplitude to aid explanation.

Trace 4 (magenta) is the Digital Sync Output, SDOR0,
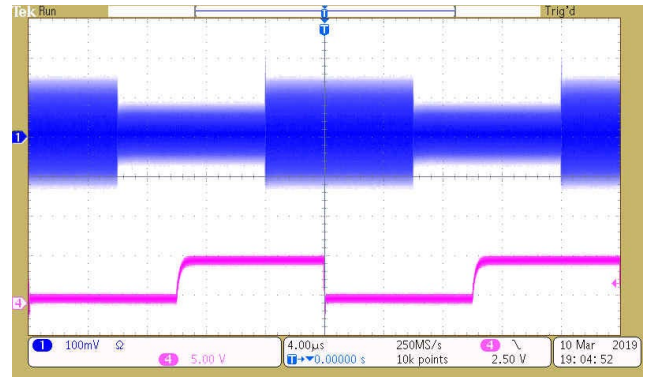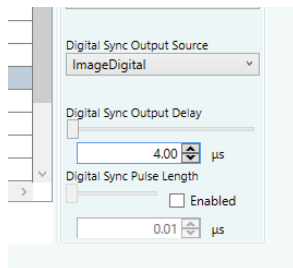on connector J7.
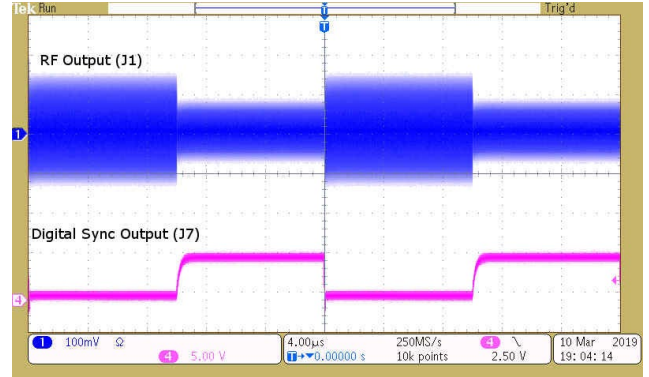
The same signals apply to the following examples below.

Digital Sync Output Delay
Using the slider, up-down arrow or direct number entry in the window, a delay can be applied to the
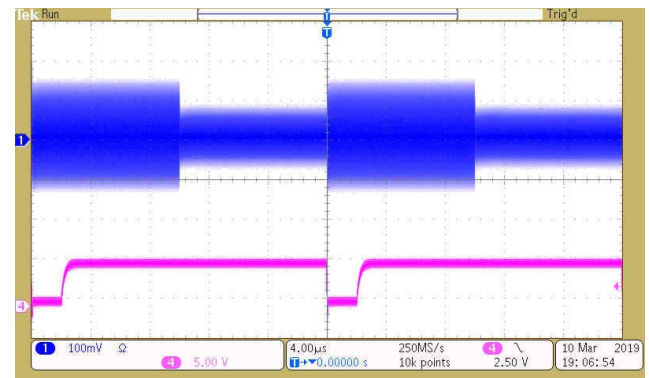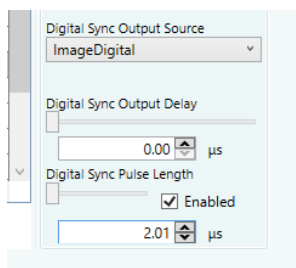Digital Sync Output.

e.g. 4usec delay

Pulse Length
Check the *Enabled* box to select a pulse per Image point rather than a constant logic level per Image
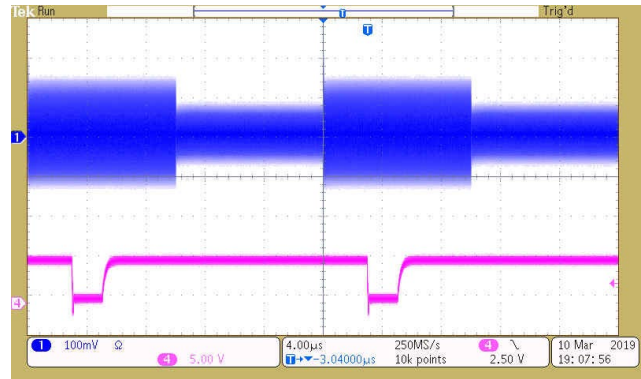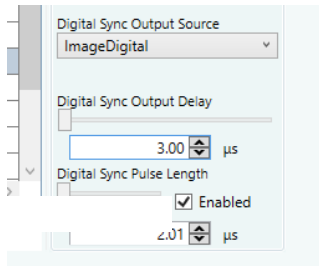point

e.g. 2usec pulse width , (not delayed)

Pulse length will not exceed Image point duration (clock period).

Pulse Length with Delay
A delay can also be applied to the pulse

e.g. 2usec pulse width , 3usec delay

SDIO output switching time

iMSx-build	Fall time	Rise Time	
	All bits	Bits 0…3	Bits 4…11
Rev A	50ns	800nsec	800nsec
Rev B	50ns	100nsec	800nsec
Rev C	50ns	100nsec	800nsec
Rev D	50ns	50nsec	50nsec

Pulsed or Level Selection

From SDK 1.8.9 and later, SDIO bits for pulsed length control can be individually selected. Unchecked bits will exhibit a constant logic level for the entire image poimt duration.

An option to software invert SDIO output sense is now provided
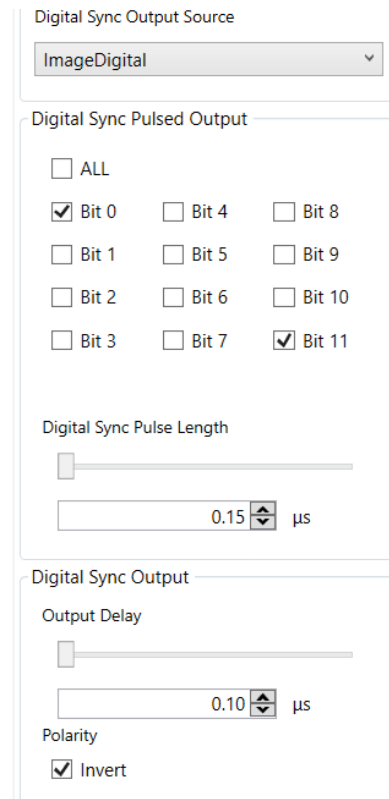
8: Set Player Configuration
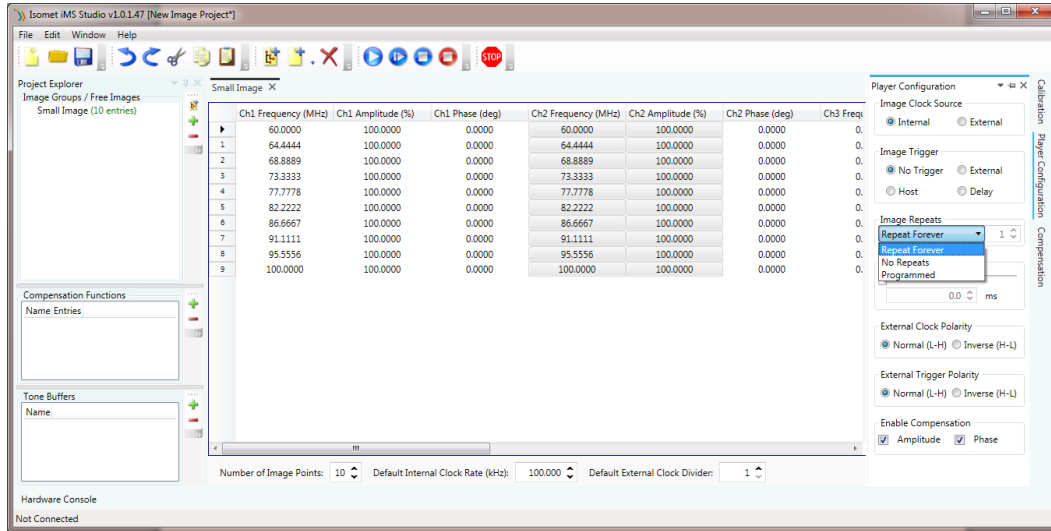
Image Clock Source: ***Internal***
Image Trigger: ***No Trigger***
Image Repeats : ***Repeat forever***
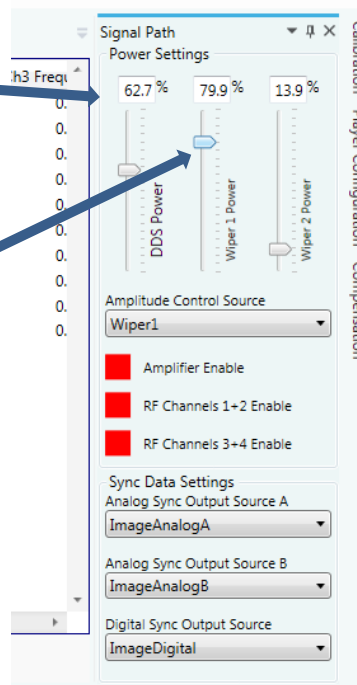

9: Set power levels
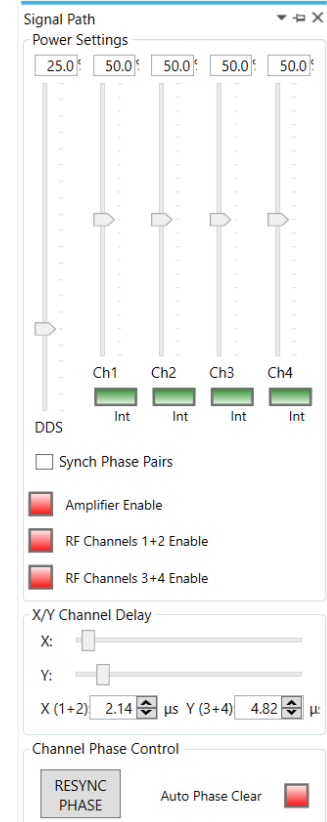
In this example for iMS4-revB

(revB)

(revC, revD)

DDS power = 63%

Amplitude Control Source = Wiper-1

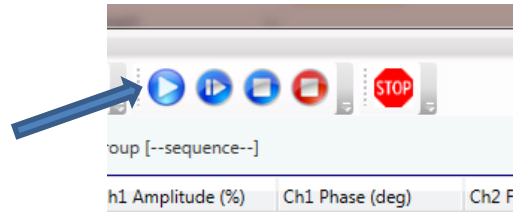All channel amplitude
Wiper-1 setting = 79.9%

*An equivalent view for later build revisions
is shown in the right hand pane:*

In this case,
    DDS power = 25%

    Channel specific amplitude
    Ch1 = Ch2 = Ch3 =Ch4 = 50%

10:     Start Play

Example 2: Tone Buffer Mode
Create Buffer with 16 tones on 2 channels.
Channel 1: Linear frequency increments, 150-90MHz
Channel 1: Linear amplitude slope : 100 – 70%
Channel 2: Static frequency increments, 120MHz
Channel 2: Static amplitude : 55%
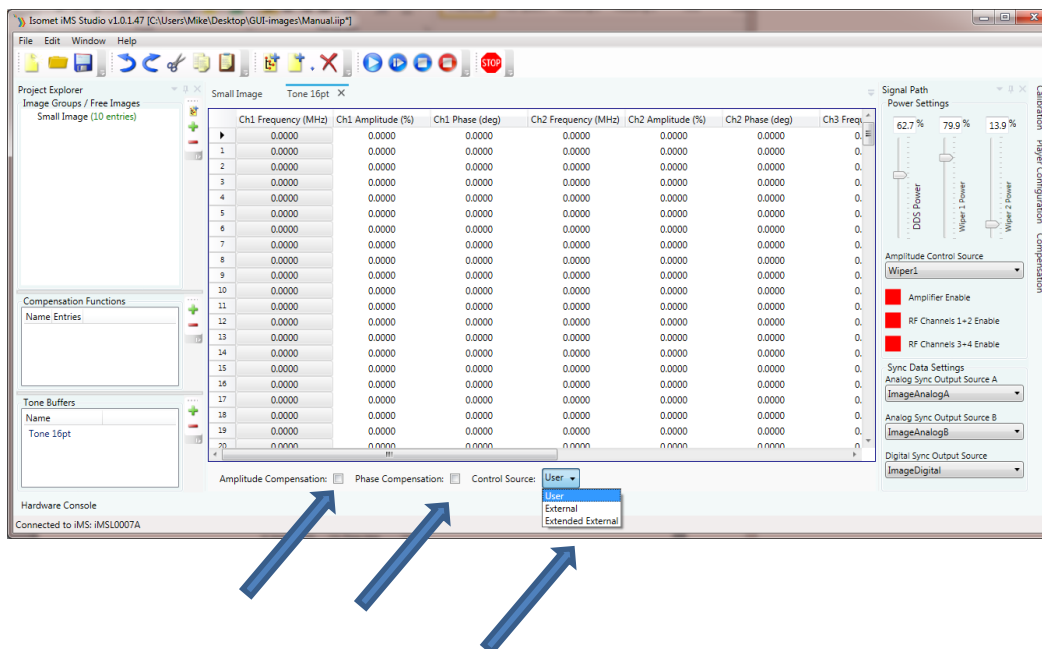No Compensation LUT applied
iMS4 only. No connected power amps.
Tones are selected using the GUI software (USER)

1:      Click in the Tone Buffer window, bottom left of main window . Edit the name if desired.

or click " **+** " to add another buffer file. A Tone Buffer tab is created

The input array will fill with 256 rows = 256 x 4 channel F/A/P data points
Not all 256 need be used.

In this example we are not applying compensation table.

2:      Uncheck *Amplitude Compensation* box, *Phase Compensation* box

3:      In the *Control Source*, select *User*

        For external control, select *Extended Control* (disregard *External*).
        Apply external inputs to the LTB address pins on connector J8
        (See J8 Connector Pin out table, Alternate Use colomn)
   Note: unterminated LTB address bits are pulled high.

The 256 possible F/A/P tones may be addressed at up to 90KHz rate using the 8x external LTB address bits on connector J8 , (pins 3,4,5,6,16,14,7,8). See page 31 for further details.

4:      **Ch1 Frequency,** enter end point values
        Tone 0, enter 150.00 MHz 9 (Start) ; Tone 15, enter 90.00 MHz (End)

5:      **Ch1 Amplitude** , enter end point values
        Tone 0, enter 100 % ; Tone 15, enter 70 %

6:      **Ch2 Frequency**, enter end point values
        Tone 0, enter 120.00 MHz 15 (Start) ; Tone 15, enter 120.00 MHz (End)

7:      **Ch2 Amplitude**, enter end point values
        Tone 0, input 55 % ; Tone 15, input 55 %

8:      Repeat for **Ch3** and **Ch4** fields if required.

Use the Interpolate feature to fill the remaining 14 cells
For each column:

        - Left click on Start cell
        - Hold down the shift key
        - Navigate to the end cell and left click
        (This should select and highlight all 16 cells)
        - Right click to open sub window
        - Select Interpolate
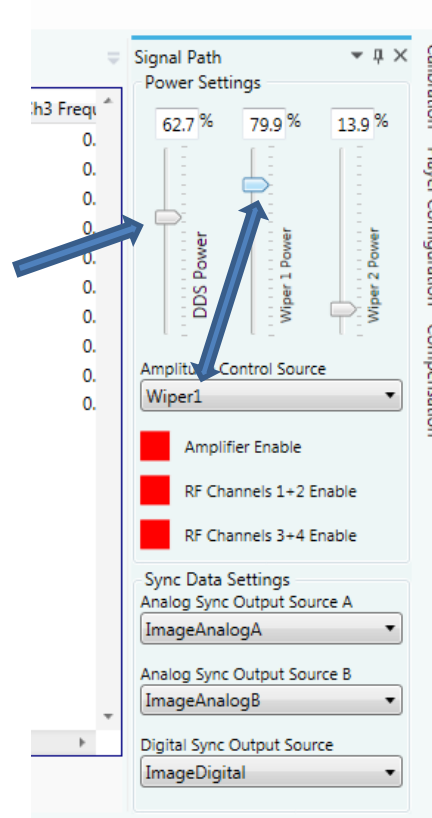

23
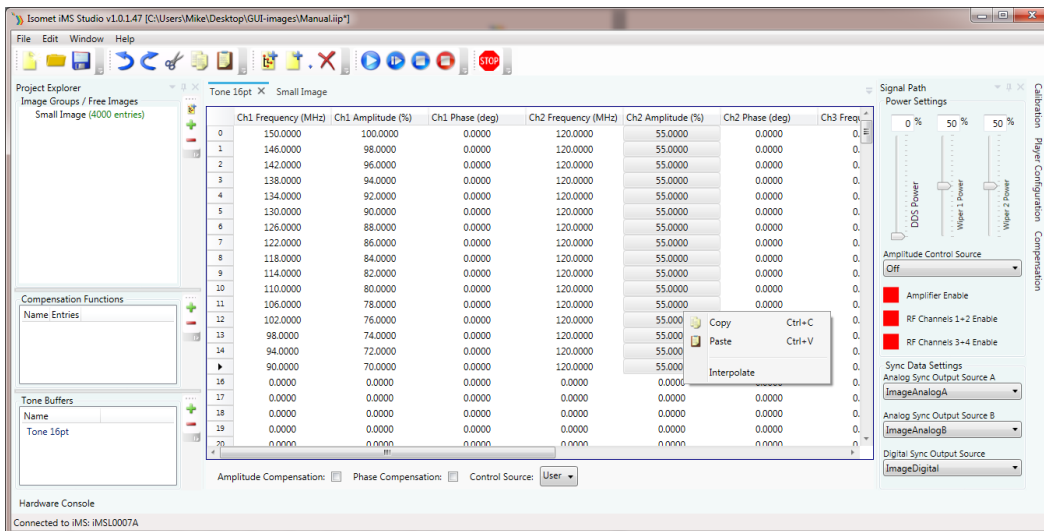
8:      Set power levels
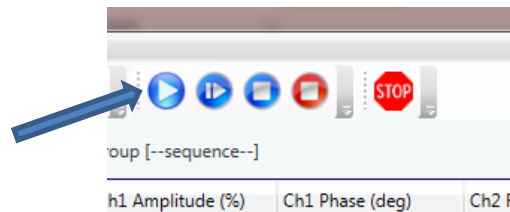
In this example

DDS power = 63%

Amplitude Control Source is Wiper-1

Wiper 1 setting = 80%

Rev-C, the equivalent settings are
Ch1 = Ch2 = Ch3 =Ch4 = 80%
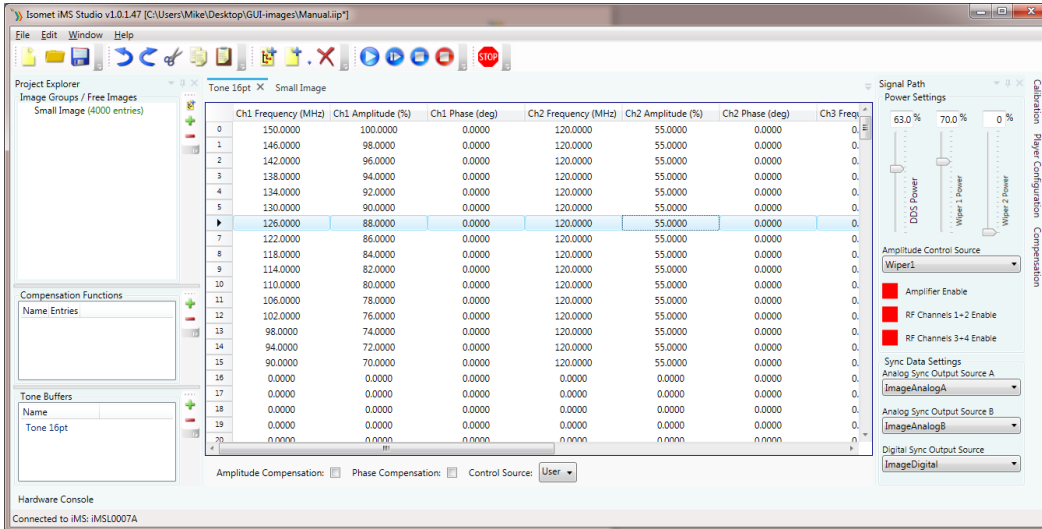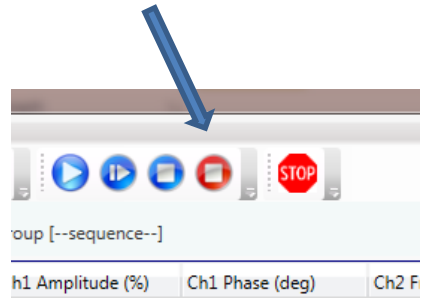
9:      Enable output

10: Tone Selection

Click on then desired Row to output that frequency set


11:      To disable output

Click as shown

Example 3: Enhanced Tone Mode - Frequency Ramp
Typical mode for AO Scanning applications, non-beam steered AO deflectors

a. To enable sweep or step modes, 'hit' the large square **On/Off** button (upper right). Colour will change from Red to Green

b. Using the pulldown **Mode** menu, one for each iMS4 output channel (**1,2,3** or **4**), select the sweep type. In the example below Frequency Sweep no (Dwell) is selected on all Channels.
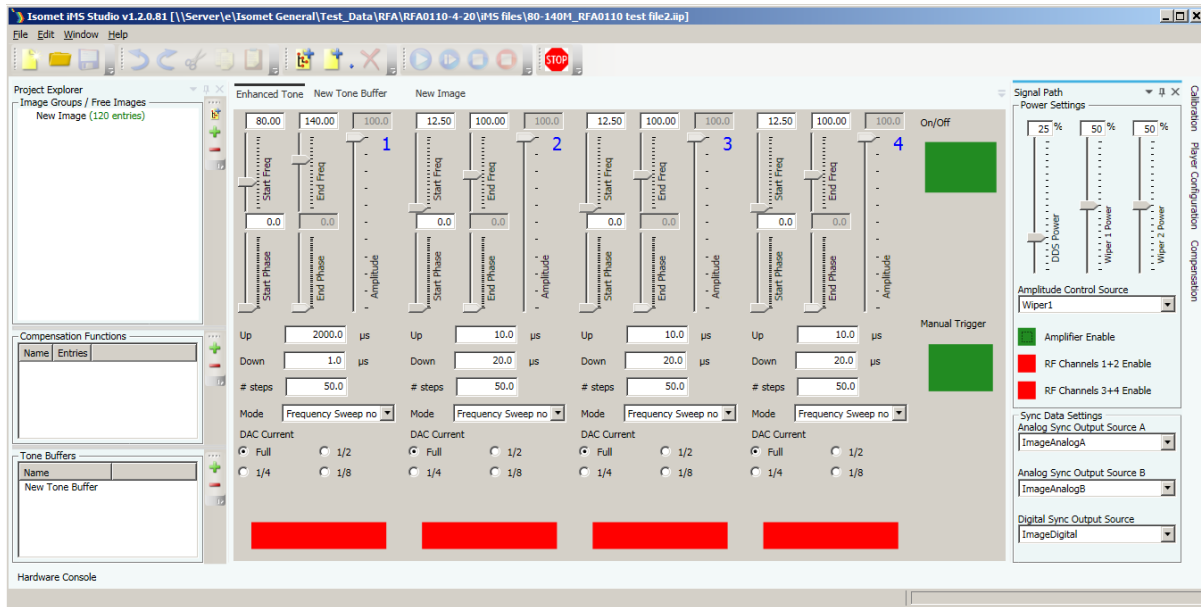
Consider Channel 1 (**1**) above,

Pull down menu
Mode selected = **Frequency Sweep no dwell**.

Sliders
- Start Freq = 80MHz.
- End Freq = 140MHz.
In this case Start Phase slider as no meaning.

Input windows
- Up (rising) slope = 2000us duration,
- Down (falling) slope = 1us
- Number points = 50 points (i.e. 50 points Up and 50 points Down)

Buttons
- Full scale DAC current selected. Normal condition
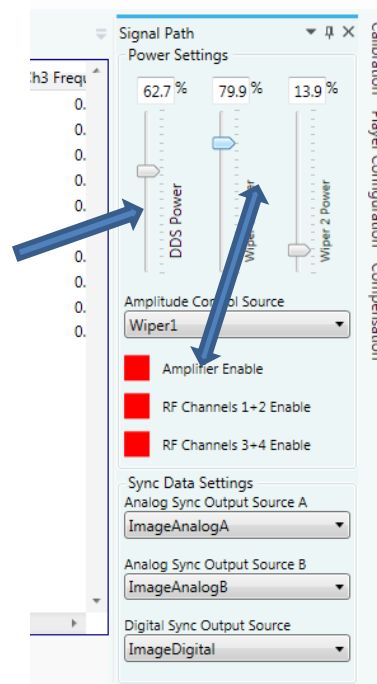- **Manual Trigger** is selected (button is Green)

Set amplitude

In this example

DDS power = 63%

Amplitude Control Source = Wiper-1

Wiper 1 setting = 80%

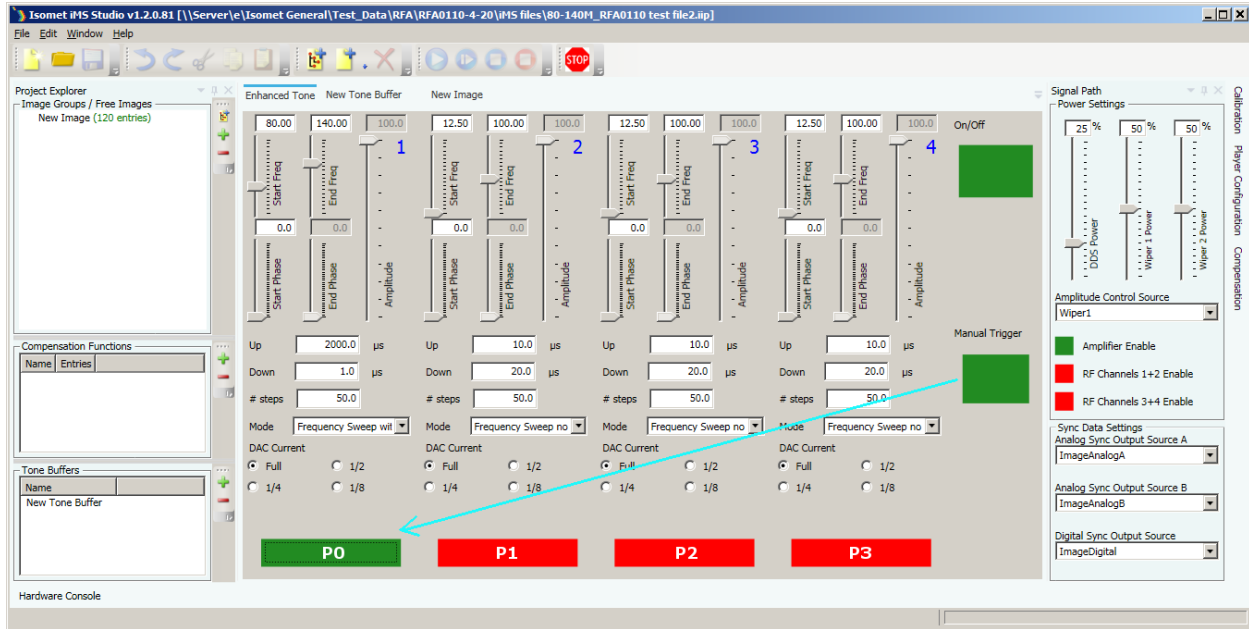*Rev-C, the equivalent settings are
Ch1 = Ch2 = Ch3 =Ch4 = 80%*

Ramp or Step Trigger Inputs

- With ***Manual Trigger*** selected (button = green), the Ramp or Step is initiated using the dedicated buttons across the lower edge of the Channel window area.

  Logic:
  Button green = profile bit (Px) high
  Button red = profile bit (Px) low.

(Manual trigger)

- For external control using 5V compatible logic, the **Manual Trigger** button must be deselected (= Red).

The sweep is then initiated by toggling the profile inputs (P0..3) on connector J7 .
It is not controlled from the SMA inputs J10 and J11

Each channel has a specific profile input.

Connector, pin	Profile input	iMS4- output
J8, pin 3	P0	Sweep output J1
J8, pin 4	P1	Sweep output J2
J8, pin 5	P2	Sweep output J3
J8, pin 6	P3	Sweep output J4

Unless requested at time of order, the default iMS4 interface for external digital signals is opto-isolated. A dedicated 5V supply is required on connector J7 or J8

To exit *Ramp mode* and return to *Image Mode* or *Tone Buffer Mode*, 'hit' the large square *On/Off* button (upper right) and ensure colour = red

Example 4: Calibration Mode
Use internal amplitude control, Wiper 1.
Apply caution with initial power settings.
Set slider of AO centre freq e.g. 80MHz
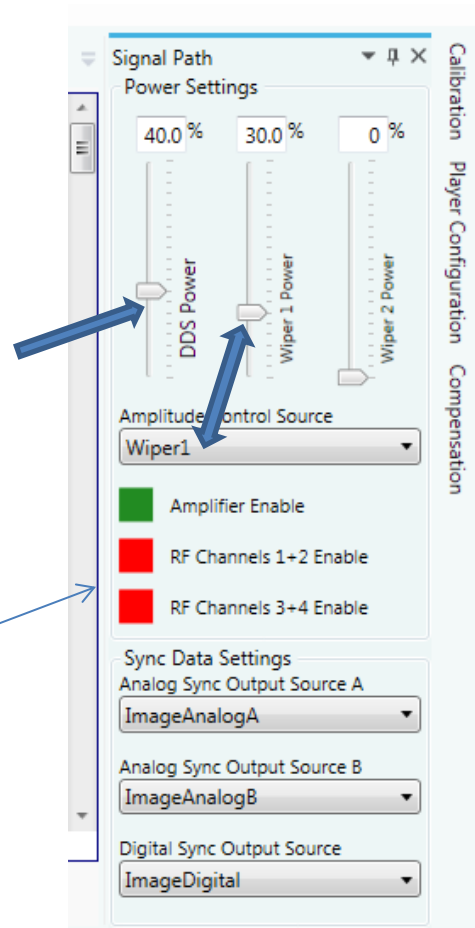External Amplifier connected to J5

1:        Set power level limits

In this example

DDS power = 40%

Amplitude Control Source is Wiper-1
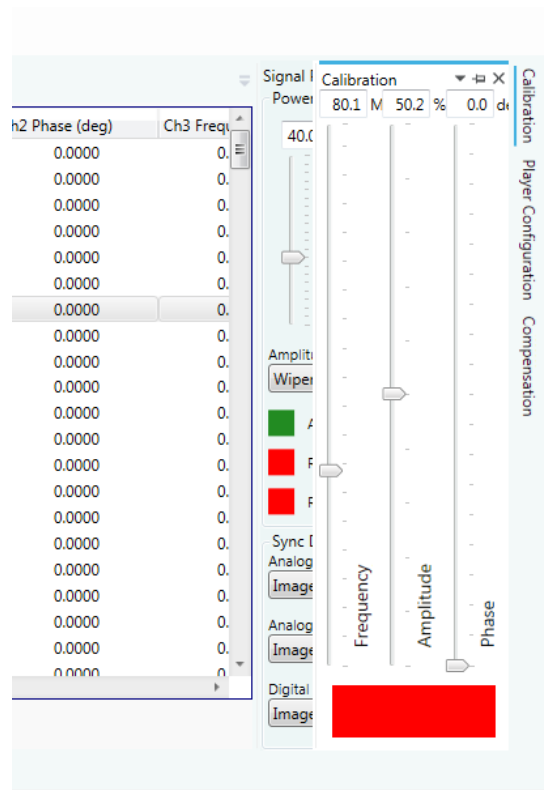Wiper 1 setting = 30%

Rev-C / Rev-D, the equivalent settings are
Ch1 = Ch2 = Ch3 =Ch4 = 30%

2:        Enable amplifier

3: Select **Calibration** tab

Adjust sliders as required

Click the large RED button to activate . This will change to Green.

Click again to disable. It will toggle back to RED.

This mode is used to create a Compensation LUTs for use with Image Mode or Tone Buffer Mode .
Please refer to app note 'iMS4 Compensation LUT Guide (rev-X) .pdf