

## Application Note 162 Using the Stimulation Features of the MP System

The MP System (MP100 or MP150) stimulation features provide a powerful vehicle for outputting a variety of wave shapes of varying duration, coincident with the data acquisition process. This application note will focus on the following output requirements:

- Short term wave output once during an acquisition
- Short term wave output repeatedly during an acquisition
- Long term wave output during an acquisition

The difference between a short and long term wave output is related to the number of points describing the wave in question. A short term wave has less than or equal to 4096 points, a long term wave has more than 4096 points. Also, all long term waves are considered arbitrary waveforms. Arbitrary waveforms don't have to be long term waves, but the opposite is always true.

The short / long distinction exists because the MP hardware units have a specific amount of built-in memory available for waveform output, as dictated by *AcqKnowledge*.

**MP100 analog output buffer:** 4096 sample points (8192 bytes).

**MP150 analog output buffer:** up to 512 Ks per analog output channel with *AcqKnowledge* 3.9 or above; software-limited to 4096 sample points with *AcqKnowledge* 3.8 or below

This dedicated memory is called the output data buffer. The MP units also have memory dedicated to acquiring (inputting) data, but this memory is not relevant for this application note.

If the waveform which will be output exceeds the output data buffer length, the MP hardware unit requests that the balance of the data be sent once space is made available in the output data buffer. Naturally, if the output waveform fits completely inside the data buffer, the outputting process can be more efficient (and thus faster) when compared to the case where the MP unit is requesting more data to fill the buffer, before the whole waveform can be output.

An additional factor affecting waveform outputting concerns the storage mode selected for the input data. The MP System has two basic data storage modes:

- **MP100 or MP150 mode** (includes Averaging acquisitions)
- **Memory mode** (includes acquisitions to Disk)

Usually, the MP System is operated in Memory mode. In this case, input data is collected by the MP unit and sent to the computer, **during** the acquisition, at high speed where the data is plotted on the computer screen and simultaneously stored to the computer's RAM or Disk.

In MP100 or MP150 mode, the input data is stored only to the MP System's internal input data buffer and then downloaded to the computer only **after** the acquisition is completed. MP100 or MP150 mode is useful when the user wishes to acquire data at very high rates. These cross-over rates and characteristics are:

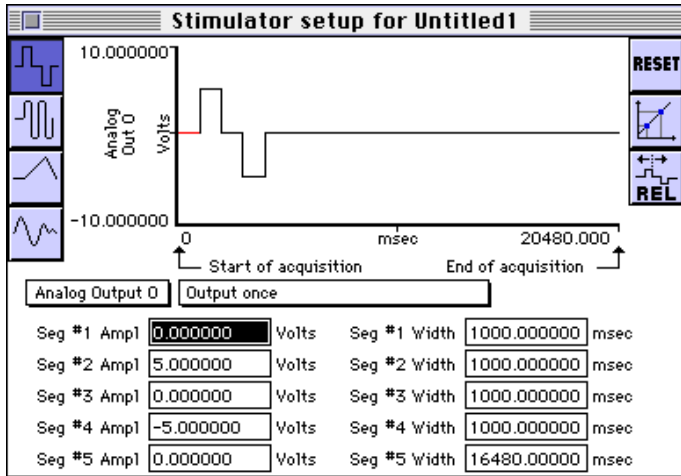
- **MP100:** Crossover rates are in excess of 10-16 kHz aggregate. When operating in MP100 mode, input data acquisition lengths are limited to 16 K samples or less.
- **MP150:** Crossover rates are not applicable. When operating in MP150 mode, input data acquisition lengths are limited to 6 M samples or less.

If the MP100 or MP150 mode is chosen for the respective MP System, then waveform outputting, simultaneous with the acquisition, is limited to short files. However, it is possible to "wrap around" this short output data file so that the waveform is output continuously during MP acquisition. This mode is selectable by choosing this function in the Stimulator Setup dialog box. The following dialog boxes illustrate how to set up the stimulator for both "Output Continuously" and "Output Once."

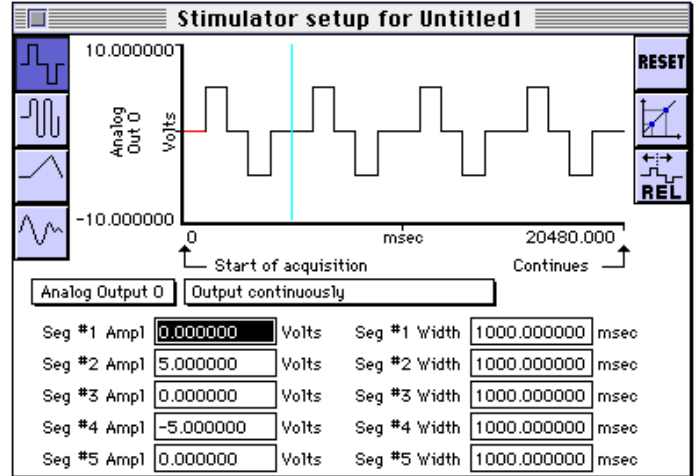
MP100 or MP150 mode is used when data needs to be input and output at high speed, and when relatively short duration acquisitions are suitable. These requirements are typically manifested when performing general stimulus/response tests.

If Memory mode is chosen for the MP System, then waveform outputting, simultaneous with the acquisition, is possible for either short or long files. In Memory mode it's possible to perform all functions that are permitted in MP100 or MP150 mode; for the MP100 only, upper sampling rate limits are reduced in Memory mode.

If the stimulator dialog setup is used to create your output waveform, the waveform will always be a short term wave. Namely, the canned waveform constructed by the dialog will always fit into the 4096 point limit for short term waves. Whether "Output Once" or "Output Continuously" is chosen makes no difference as to the type of wave. In both cases, the wave output will be a short term wave.



Output Once



Output Continuously

When long data files require outputting, then the MP System will need to run in Memory (or Disk) mode. In this case, the MP unit will send acquired data to the computer and the computer will simultaneously send the data to be output to the MP unit. In these cases, the limiting output rate is:

- **MP100:** Roughly 5 kHz (assuming 1 channel acquired while data is being output).
- **MP150:** Roughly 20 kHz (assuming 1 channel acquired while data is being output).

For higher outputting rates in Memory (or Disk) mode, limit the length of the output file so the entire output waveform can be loaded into the MP output data buffer, so the effective output rate will be significantly increased.

The following table illustrates the various output options and limitations for the MP System:

Output Mode	MP100 System		MP150 System	
	Memory Mode	MP100 Mode	Memory Mode	MP150 Mode
Once	Yes (up to 10 kHz)	Yes (up to 30 kHz)	Yes (up to 100 kHz)	Yes (up to 100 kHz)
Continuously	Yes (up to 10 kHz)	Yes (up to 30 kHz)	Yes (up to 100 kHz)	Yes (up to 100 kHz)
Arbitrary (≤4096 points)	Yes (up to 10 kHz)	Yes (up to 30 kHz)	Yes (up to 100 kHz)	Yes (up to 100 kHz)
Arbitrary (>4096 points)	Yes (up to 5kHz)*	No	Yes (up to 20 kHz)*	No

**\* IMPORTANT NOTE**

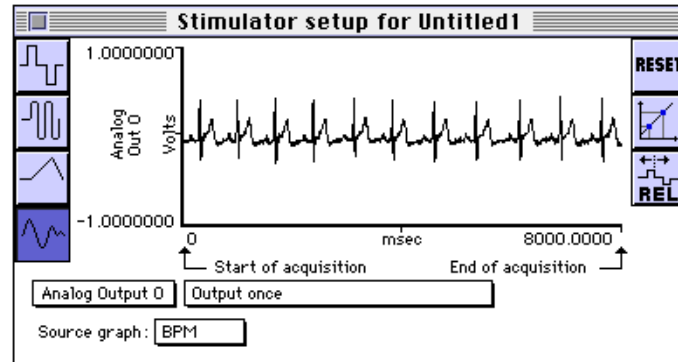
Arbitrary waveform output of long data files, during acquisition, is a complex process. This complexity results from the contribution and interaction of many factors. In these types of acquisitions the speed and OS type of the computing platform is quite relevant to overall performance. A relatively slow computer may perform to a different level than indicated in the above tables.

Because the computer type is so influential, messages regarding errors in the acquisition may be somewhat cryptic at times. Generally considered, if the above limits are exceeded, then the respective ACK-MP System will provide an error message which says:

**Communications Error: Acquisition Terminated**

The following dialog illustrates the arbitrary file outputting process. In this case, an ECG record is being output simultaneously with a data acquisition.

- **For MP100 or MP150 mode outputting:** The arbitrary output file will be truncated to 4096 points prior to being transferred to the MP hardware unit.
- **For Memory (or Disk) mode outputting:** The arbitrary output file will be output for as long as the acquisition permits.



**Arbitrary Wave Outputting**

In the course of outputting data using the MP System, some additional factors require consideration:

- **Memory mode outputting:**  
In this case, the MP System will output additional data points beyond the length of the acquisition. This behavior results because the MP System outputting process is halted by the computer during Memory mode. To have a precise number of cycles in the output data and end the outputting with a known data value, simply increase the acquisition length by anywhere from 5 to 50ms longer than the output file length.
- **MP100 or MP150 mode outputting:**  
The MP100 or MP150 will output the last data point in the output file after the acquisition is completed. This behavior results because the input and output data are interleaved, with the input data going first.
- **When outputting cyclic data** (outputting continuously):  
Non-integer relationships between sample rate, output data points and acquisition time may result in unexpected values for the last point in the data file.
  - If memory mode is used, then the last point in the record may appear to “bounce around” because the end data point is not precisely defined.
  - In MP100 or MP150 mode, this phenomenon won't happen, but the last value may not be the desired stopping point.

In this case, simply adjust the sampling rate slightly to shift the desired end of the record into place. These characteristics are only evident in cases where the output cycles occur quickly, and are maintained up to the very end up the acquisition.