

PL2™ File System Overview

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Introduction

Recent advances in electrode technology and implantation techniques have led to a significant increase in the number of implanted electrode devices and the number of electrode sites per device. Today, it is not unusual for an investigator to record from tens to hundreds of channels. When continuous wideband data is being recorded at a 40 KHz sample rate, the data rate for 16 bit samples is 288 MB per hour per channel. That is 36.8 GB/hour for 128 channels and 73.7 GB/hour for 256 channels, not including other types of data or file system overhead. The file size quickly becomes unwieldy. Even when not recording wideband data, the files can become quite large when the channel count is high.

Accordingly, data loading time for analysis is greatly increased for these large, high-resolution files as commonly used tools run through the data channel by channel. For example, interactive per channel operations such as sorting or re-sorting waveforms in Offline Sorter™ can be time consuming and frustrating with huge files. MATLAB® and user analysis programs can take many hours just to read the data.

To address this issue, Plexon has taken the lead once again by advancing its original industry-standard recording format to develop a game-changing new file format - PL2™ - that significantly improves the efficiency of the analysis process. Depending on the file characteristics, data loading may be 10, 100 or even 1,000 times faster.

PL2 File System

The Plexon PL2 file system consists of the PL2 file format, supporting programs and software development kits. The PL2 format itself is a significant advancement in data management and can be characterized by the following facts relative to its predecessor. PL2 files:

- Are significantly faster in single channel read time depending on file length, types of data, and number of channels. Individual channels can be loaded from files hundreds or even thousands of times faster.
- Enable up to 50% faster block level reads, as in reading the file sequentially.
- Are a more general format representing all existing PLX data, plus more channels and additional types of data including system configuration and individual channel metadata.
- Generate somewhat smaller file sizes.
- Require OmniPlex Software v1.9 or later.
- Are optional - researchers have the choice to record using either the new PL2 format or continue using the original PLX format.
- Are recorded in real time by the OmniPlex Neural Data Acquisition System.
- Can be created by converting from an existing PLX file using PlexUtil 4.0 (explained in the section Converting a PLX File to a PL2 File.)

The following items and release levels provide support for PL2 functionality. All programs can be accessed through www.plexon.com.

OmniPlex Software 1.9 – The software that operates the OmniPlex Neural Data Acquisition System. Version 1.9 enables the user to record PL2 files (if desired.)

PlexUtil 4.0 – A Plexon file utility program that permits the manipulation of files including splitting and merging data. Version 4.0 supports PL2 files and adds the ability to convert from PLX files to PL2 files.

Offline Sorter 3.3 (OFS) - The most recognized and trusted offline spike sorting software in the industry today, with more than 800 scientific publications specifically citing the use of OFS. Version 3.3 now supports PL2 files.

NeuroExplorer® 4.125 - The industry leading neurophysiological data analysis package. Version 4.125 now reads PL2 files.

PL2 Software Development Kit (SDK)– Plexon’s PL2 SDK includes MATLAB and C++ libraries for interfacing to analysis programs and languages. Single-channel and block-level reading are both supported. The MATLAB SDK is platform independent, while the C++ SDK is appropriate for use with a Windows® platform.

PL2 vs. PLX File Read Performance

Performance testing comparing the PLX and PL2 file formats resulted in the following:

- Single-channel reads as performed by Offline Sorter and MATLAB programs show improvement of hundreds to thousands of times.
- Block-level file read as performed by NeuroExplorer and the block read APIs in the C++ SDK are approximately 50% faster.

256 Channels (SPK + FP): 2 Hours Recording Time

	PLX Format 12.3 GB	PL2 Format 11.4 GB
Read SPK channel (421,000 spikes)	301.7 sec	1.7 sec
Read FP channel	301.5 sec	0.8 sec

SPK = 32 point spike waveforms
FP = 1 kHz continuously digitized field potentials

256 Channels (SPK + WB + FP): 10 Minutes Recording Time

	PLX Format 13.8 GB	PL2 Format 11.4 GB
Read SPK channel (35,000 spikes)	275 sec	0.18 sec
Read WB channel	275.7 sec	2.50 sec
Read FP channel	275.5 sec	0.08 sec

WB = 40 kHz continuously digitized wideband signal
SPK = 32 point spike waveforms
FP = 1 kHz continuously digitized field potentials

It is important to note that the performance improvement is dependent on number of channels, types of data, spiking rate, and length of the file. These tests were performed using the Data (D:) drive of a Dell T3600 Workstation. Each test was performed 10 times and averaged.

Recording PL2 Files

PL2 files are recorded using the OmniPlex Neural Data Acquisition System (OmniPlex or OmniPlex D) running OmniPlex Software v1.9 which can be downloaded online at www.plexon.com/software-downloads. After updating to version 1.9 researchers will simply need to change the recording file type in PlexControl to PL2 prior to recording.

To do so, select **Global Options** from the **Configure** menu, then choose the **Recording Files** tab. In the lower left of the page resides the file type options. The top option, **.PLX File Only**, is the default. Researchers may then select either **.PL2 File Only** or **.PLX File and .PL2 File** to record using both formats in parallel. Click **OK** to save changes. A more detailed explanation with screenshots is available in the *OmniPlex User Guide*.

MAP System users will be able to convert their PLX files into PL2 files (see next section); however, it is not possible to natively record PL2 files using the MAP System.

Converting a PLX File to a PL2 File

There are many research laboratories with large data previously recorded in the PLX format that will want to convert their files, leveraging the benefits of the faster loading. Plexon enables that process through PlexUtil 4.0.

Researchers wishing to convert PLX to PL2 files will first need to do the following two things:

- Download PlexUtil 4.0 from the Plexon website at www.plexon.com/products/plexutil, and
- Ensure that their OmniPlex and/or MAP System license keys have been upgraded (at no charge) to unlock access to the PL2 conversion functionality.

Upgrading the license keys is a simple process. Researchers should email support@plexon.com with their OmniPlex and/or MAP System license key serial numbers (found on the back of the key following the "SN") and request the PL2 upgrade codes. Plexon will reply with the codes and further instructions. With the upgraded license keys and PlexUtil 4.0 running on the computer, researchers will be ready to convert files. Plexon's Technical Support team is available to assist with any questions.

About Plexon Inc

Plexon is a pioneer and leading innovator of custom, high-performance data acquisition, behavior and analysis solutions specifically designed for scientific research. We collaborate with and supply thousands of customers including the most prestigious neuroscience laboratories around the globe driving new frontiers in areas including basic science, brain-machine interfaces (BMI), neurodegenerative diseases, addictive behaviors and neuroprosthetics. Plexon offers integrated solutions for *in vivo* neurophysiology, optogenetics, and behavioral research – backed by its industry-leading commitment to quality and customer support. For more information, please visit www.plexon.com.

Sales Support

For Sales Support, email info@plexon.com or call +1 (214) 369-4957.

Technical Support

If after reviewing this document, you would still like to access Plexon's Technical Support, we are available via several communication channels. You are invited to reach us through email, on the phone, or even over Skype utilizing instant messaging, voice, and/or video as follows:

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