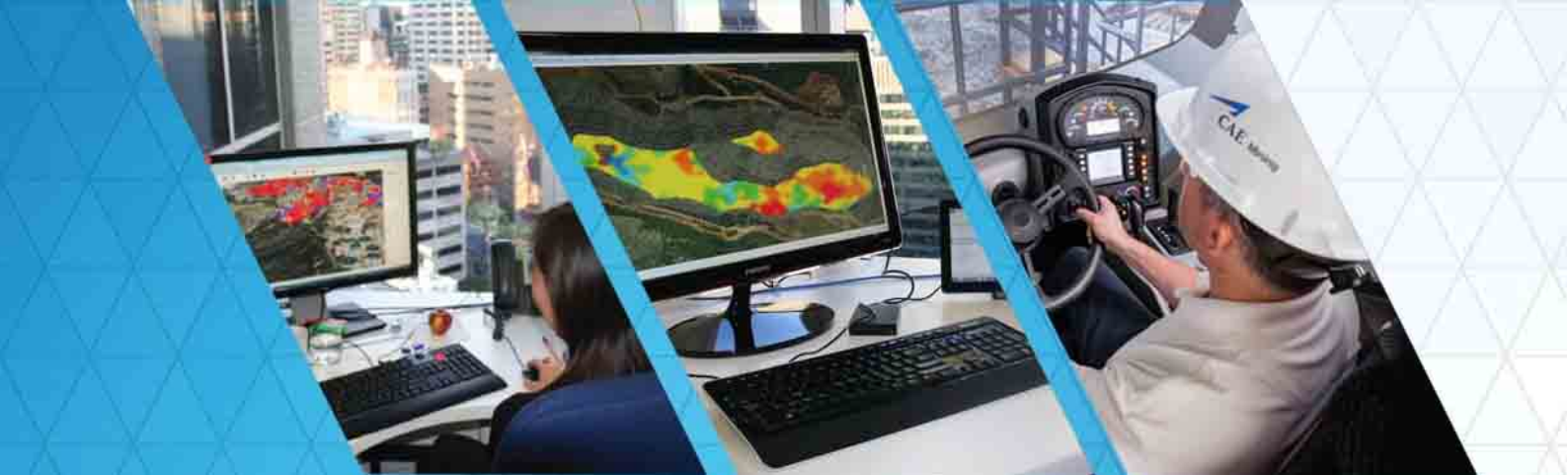


# Studio 3



## Precision Settings User Guide



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## EXECUTIVE SUMMARY

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This document outlines the differences between the use of single and extended precision files in Studio 3.

Studio 3 has taken the concept of mixed precision data management from Studio 2, and provides a single precision environment by default, with optional support for extended precision files.

There are implications surrounding the choice of precision value, and for this reason it is important that a full knowledge of the impact of that choice can be provided. This document is one resource available to explain the concepts and processes behind precision management from both a file- and project-perspective.

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# 1 OVERVIEW

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## Purpose of this document

This document is intended as a reference guide to enable you to make fully informed decisions regarding the use of single and/or extended precision projects and/or files in Studio 3.

## Prerequisites

You should have some working knowledge of the file structures associated with Datamine data types. The basic concepts of 'precision' are explained, but it would be useful if you also had an appreciation of how these settings are managed in Studio 2.

## Acronyms and Abbreviations

Acronym	Description
EP	Extended Precision
SP	Single Precision
S3	Studio 3
DM	Datamine

## More information

Other sources of information relating to precision settings are:

- Your Studio 3 online Help system (particularly **Studio 3 Help | Using Studio 3 | General Concepts**, and **Single and Extended Precision**)
- The Studio 3 Migration presentation describes single and extended precision file implications in detail.

## 2 INTRODUCTION

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### What is meant by 'precision'?

Studio 2 and Studio 3 use the concept of 'precision' to determine the resolution of data held within the underlying Datamine format files associated with data objects. This resolution comes in one of two forms: single or extended.

Single precision (SP) files are of a lower resolution than extended precision files. This means that whereas they are generally smaller in size than an equivalent EP version, the reduction in precision means that they are not as exact, from a numerical accuracy perspective. However, this may or may not be an implication for the data files you are using.

Extended precision (EP) files (sometimes referred to as 'double precision' files), introduced in Datamine Studio version 2.1, provide a higher level of accuracy than their single precision equivalents, but are also associated with larger file sizes. Again, this may or may not have an adverse affect on your operations in Datamine Studio products.

The choice of which precision you use is entirely up to you; generally it is a choice you would make at the advent of a project, although it is possible to alter the precision values of files using Studio's various utilities and dialogs for some (but not all) scenarios.

Being more specific; the difference between SP and EP is in the way numeric values are stored. Both store numbers as floating point values, but in SP files, this is restricted to 24 bits of precision, representing 6/7 significant digits, whilst in EP files, this is extended to 53 bits, representing 16 significant digits.

To put this into context consider that 16 significant figures is sufficient in metres to compare the circumference of the earth (4e7 metres) to a human hair (1e-4 metres), and still have a few significant figures left over.

Single precision files permit a maximum of 64 data columns, whereas EP files extend this to 256 possible columns.

For a more technical comparison of SP and EP files, see Appendix A.

### Which Precision is Correct?

In short, either. The choice of precision will depend on the type of data you wish to represent, and your decision may also be based on the processing power you have available in order to manipulate data files. Just as importantly, if you are intending to use existing data files within your current project, the precision of these files may determine the type of project you create. For example, if you are intending to use extended precision files, you will need to create an extended precision project.

Conversely, if only single precision files are relevant to your project, you should create a single precision (default) project type. This can be upgraded at a later time (to extended precision) if required.

### Studio 2 Precision Settings

Studio 3 has adopted a simple and user-friendly approach to controlling the precision settings for projects (and subsequently files), which is shown in Chapter 3, however, as a comparison, it is worth mentioning that Studio 2 precision was set using environment values. A manual

alteration of the Datamine Environment file (*datamine.env*, or *local.env*) to be altered to force all subsequent actions to be taken place according to the new precision file.

### **Possible Conflicts – Projects and Files**

The existence of two separate precision values, although allowing for a flexible approach to data management, and easier optimization of working processes, it does raise issues when mixed precision files exist; to execute Datamine processes and commands, your system needs to 'know' which precision values are being dealt with at any given time, and there are other implications when adding files to a project.

When a precision setting is made, Datamine effectively 'swaps' to that setting for subsequent operations. In Datamine terms, this means that a different *Software Server* is used for each situation. So, if you are working in single precision mode, and you wish to read a file in extended precision, the active server will not be able to process that resolution of data.

So, it is necessary for Studio 3 to recognize the precision values of each and every project file, and also to check for the precision values of all incoming files, making sure that no data resolution conflicts occur in any subsequent operations.

In other words, it is vital that projects are labelled with the relevant precision and all associated files' precision values are 'in agreement' with that setting.

The way that Studio 3 achieves this is explained in the following section.

## 3 STUDIO 3 AND DATA PRECISION

### Choosing Your Precision

Ideally, you should decide on the resolution of your project when it is created, this will ensure that all generated files are in tune with the precision of the project in question.

Whereas it is possible to change the resolution of a project from single to extended precision at any time, you will be unable to 'downgrade' the resolution of an extended precision project to a single precision project using Studio 3 alone (strictly speaking, it is possible to alter the precision of any file, in any 'direction', using the Studio 3 Table Editor, although this practice should be avoided as it leads to a degradation of data – project files amended in this way may not provide the required resolution for required results).

### Studio 3 Default Precision Settings

By default, all Studio 3 projects provide support for single precision files only to ensure maximum compatibility with existing Studio 3 projects, and Studio 2 projects, but this can be changed when a new project is created (see "Creating Projects", below). You can also create an extended precision project from a single precision project, but not *vice versa*. For this reason, single precision projects are the default setting in Studio 3, as it is with Studio 2.

### Precision Selection Guidelines

Before deciding on a precision setting for your project, you should be aware of the following:

- Extended precision projects will support the inclusion of both SP and EP files, however only extended precision output files will be generated by internal processes.
- Single precision projects will not support the addition of extended precision files, and will only generate single precision files.
- You can upgrade your project from single to extended precision using Studio 3's proprietary functions (although the project will then have to be closed, and re-opened), but not the other way round.

This situation can be summarised using the following table:

	EXTENDED PRECISION PROJECT	
	Read	Write
EP Files	Yes	Yes
SP Files	Yes	No
	SINGLE PRECISION PROJECT	
	Read	Write
EP Files	No	No
SP Files	Yes	Yes

The arrows at the side of the table represent the possible project 'upgrade' route.

If an attempt is made to load in a conflicting data file, the appropriate messages will be issued by Studio 3.

## Setting Your Project's Initial Precision

The **Project Wizard** controls which precision setting your new project will adopt, with the addition of a new check box on the first screen:

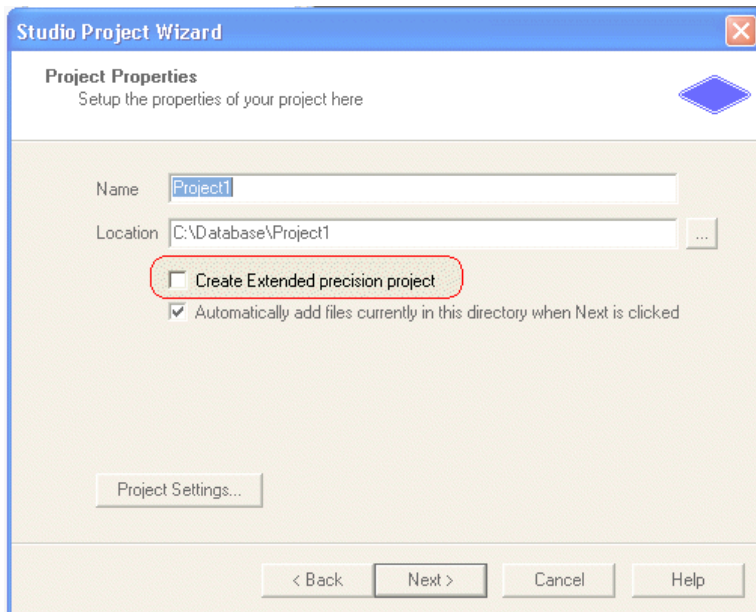


Fig 1. The Project Properties screen



The default setting for all new Studio 3 projects is for single precision projects. You must select the *Created Extended precision project* check box in order to provide initial support for EP files.

The next screen, **Project Files**, will only show files that can be loaded into the selected project type. For example, if you have elected to create a single precision project, you will not see any extended precision files listed on the **Project Files** screen:

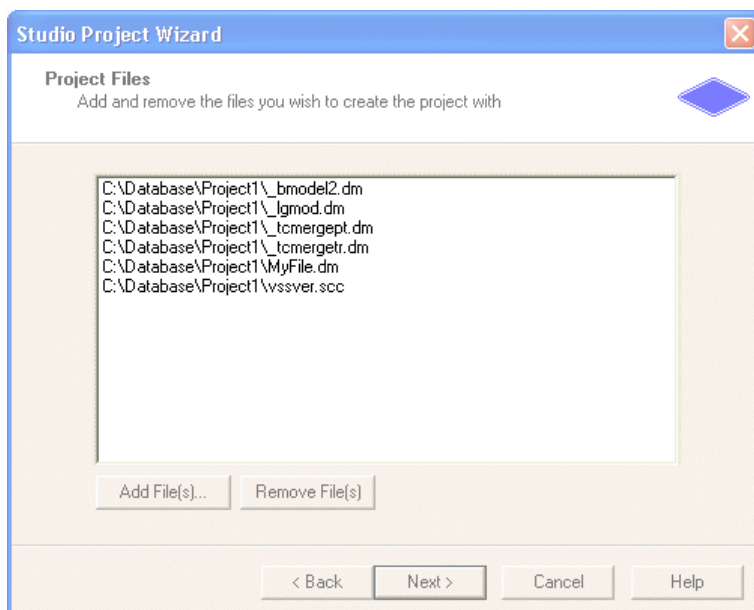


Fig 2. The Project Files screen

Note that you will also be unable to add any EP files to the list using the **Add Files...** button if a single precision project is being created. Click **Next** and **OK** to create your project in the selected precision.

### Managing Single Precision Projects

If you have created a single precision project, you will be unable to add EP files to it, using either the Datamine file loading functions (under **Data | Load** in the **Design** window) or by attempting to use the Data Source Drivers to create extended precision files.

For example, if you have created a single precision project, and use the Data Source Drivers approach to import data from an Excel® spreadsheet (using **File | Add Files to Project | Imported from Data Source**, for example), and then import a text file, you will not have the opportunity to generate an extended precision file as this option will be disabled:

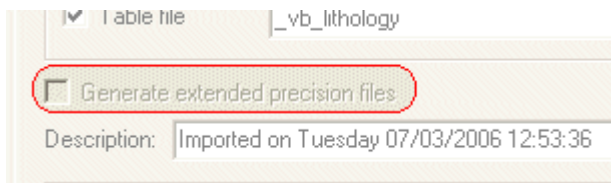
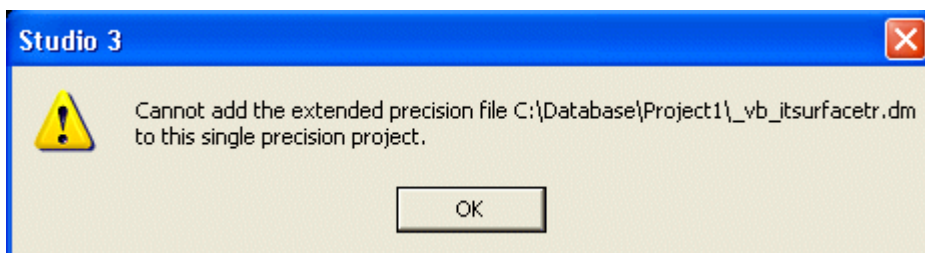


Fig 3. The Import Files dialog example for a single precision project

Similarly, if you try to load a file from an area outside of the current project directory (using **Data | Load | External Datamine File** options), any attempt to load an EP file will result in a warning message being shown, and the load operation being cancelled:



This dialog will be shown whenever an attempt is made to load an EP file into an SP project.

### Managing Extended Precision Projects

If you have created an extended precision project, you can load or import single or extended precision files. All files generated in EP projects will be extended precision.

### Recognising File Precision Types

There are two different levels at which precision can be identified; project and file.



In an extended precision project, different icons are used to represent the precision of loaded *files*.

This differentiation can be found in the **Project Files** control bar. Single precision files are recognizable by their Datamine diamond logo with an 'SP' overlay, as shown in the *bottom* image on the left. All extended precision files are shown, in iconic format, as a diamond without an overlay, as shown in the *top* image on the left.

In addition to the file differentiation, you can also see the precision of the Project in a similar manner – single precision projects will have an ‘SP’ overlay icon (and will only contain single-precision files, whereas extended precision projects will not have an overlay, and may contain a combination of single and extended precision project files associated – although only extended precision files will be generated during subsequent operations..

Once you have created an extended precision project, it is *strongly recommended* that you leave this precision for the duration of the project. Whereas it is possible to manually alter the precision value of Datamine files (as opposed to project files) from EP to SP format, this process will result in the degradation of data, and may cause accuracy levels to fall outside of acceptable limits.

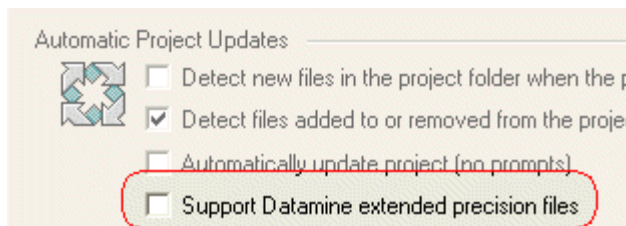
It is not possible to ‘downgrade’ an EP project file to SP in Studio 3.

## Going from Single to Extended Precision

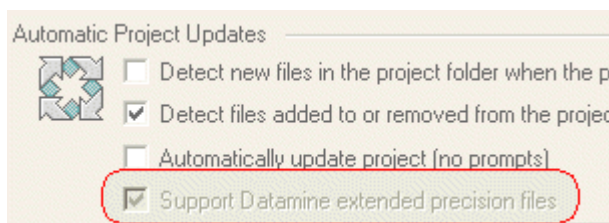
Single precision files can be enhanced to included support for extended precision files.

To do this:

1. Load your single precision project
2. Select **File | Settings** and on the **General** screen (shown by default, select the *Support Datamine extended precision files* check box. Note that this option is only available for single precision files, and is shown as selected and disabled for extended precision files, i.e.:



Single Precision Project Files Option



Extended Precision Project Files Option

3. Select **File | Save** followed by **File | Close**.
4. Reopen the project. This closing and reopening will ensure that the software 'engine' dealing with extended-precision files (known as the 'Precision Server') is re-started. Support for extended-precision files will then be available.

## 4 STUDIO 2 PROJECTS IN STUDIO 3

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As with Studio 3, Studio 2 also provides support for extended and single precision files.

When a Studio 2 project is loaded into Studio 3, the type of project that is being imported is detected automatically, and subsequent work within the project will be on the basis of the imported precision status; for example, if a single precision Studio 2 file is loaded, you will not initially have support for extended files, although this can be provided using the instructions shown in the previous section.

### Using Studio 2 and Studio 3

If you are using Studio 2 and Studio 3 to manage your projects, you will need to be aware of the compatibility issues between the two programs.

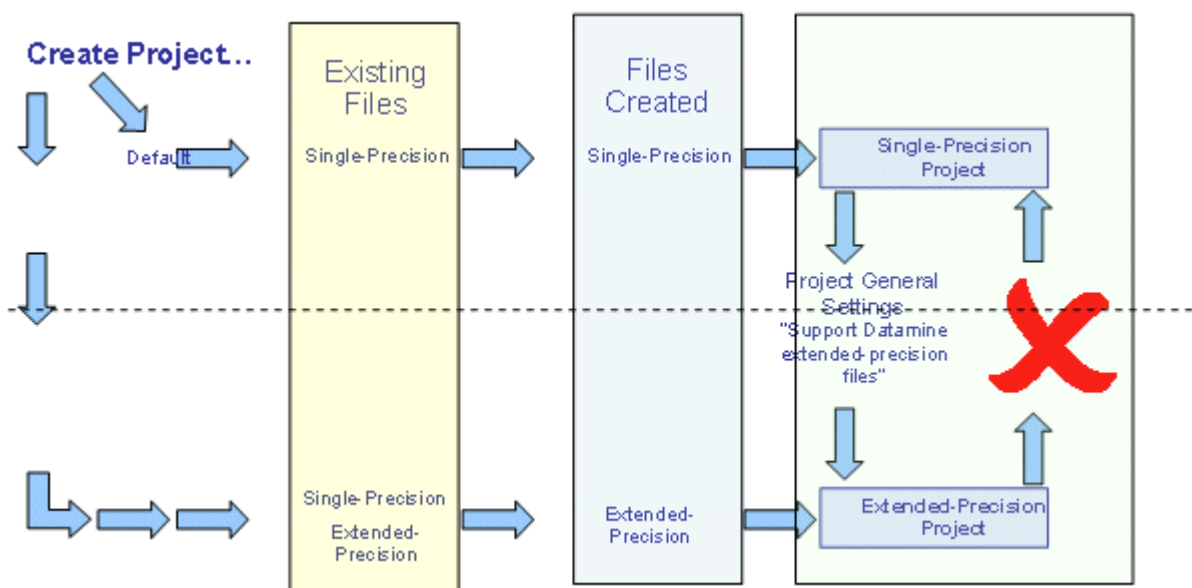
- Single precision files can be created in either application, and loaded into either application, regardless of the project precision setting (Studio 3) or the environment variable settings (Studio 2).
- You can only load either a single or extended precision file from Studio 2 in Studio 3, and the project's precision status will be detected on loading. The relevant Precision Server will then be activated, and your Studio 3 application will then react accordingly to attempts to import files of each precision.
- If you create an extended precision file in Studio 2, you will not be able to load it into a single precision Studio 3 project, but it can be loaded into a Studio 3 extended precision project.

In brief, Studio 2 files and projects are treated in a similar manner to their Studio 3 equivalents.

## 5 SUMMARY OF SP AND EP

The following summary diagram outlines the points raised by this document (document taken from 'Studio 3 Client Migration' presentation):

- There are two paths shown in the diagram: the top set of arrows (above the dashed line) represents the creation of a single precision project (the default option).
- The lower arrow 'path' (below the dashed line) represents the creation of an extended precision project.
- The area in the green rectangle represents precision alteration options and limitations for existing projects.]



# Appendix A: PRECISION TECHNICAL INFORMATION

The following information outlines technical information relating to how floating point values are stored in both single and extended precision files:

## Floating Point Representation

The IEEE-754 standard lays down the following definition of floating point formats:

Floating Point Format	Lowest value	Highest value	Mantissa Bits	Significant Digits
IEEE Single Precision	1.17549435E-38	3.402823E38	24	6-7
IEEE Double Precision	2.2250738585072014E-308	1.797693134862316E308	53	16

All Datamine software conforms to these representations of floating point numbers as implemented by the compilers which it uses to create the processor executables.

## Significant Digits

As can be seen from the table above the mantissa of a single precision float has 24 bits of precision while a double has 53 bits. Converting from bits to decimal digits gives 7 decimal digits for floats, 16 for doubles. For example 24 bits leads to a decimal accuracy of  $1/2^{24}$ , or  $6 \times 10^{-8}$ , while 53 bits leads to a decimal accuracy of  $1/2^{53}$ , or  $1 \times 10^{-16}$ . While the binary precision is exact, the decimal 'mileage' will vary slightly depending on the actual number being considered.

## Datamine Extended Precision format

The term "Extended Precision" format as used in Datamine Studio version 2.1 relates to the format used to store floating point values in the Datamine binary file. In the past all floating point operations were carried out in single precision to reduce memory and speed overheads of the computations. The original binary format of Datamine files was designed to store single precision values as efficiently as possible. As processors have evolved the benefits of using double precision have become available and the format of the Datamine files has been adjusted to allow the storage of these higher precision numbers. By choosing the Extended precision server in the Datamine environment the user is assured of using Double precision accuracy for all internal calculations. By setting the file format to extended precision as well the user is able to store the results in double precision format without losing any resolution

## Precision and Block Models

Block models are indexed by an encoding method that relies on storing the index within a single floating point value within the Datamine file format. This is the IJK field. This field value is calculated by the following expression:

$$IJK = (k - 1) + (j - 1) * Nz + (i - 1) * Nz * Ny$$

Where Nx,Ny,Nz are the number of cells in each of the directions X,Y,Z and I, j and k the local model coordinates.

Although this value is an integer it is stored as a floating point value in the Datamine file. The maximum values that can be used are shown in the table below:

Precision	Maximum IJK Value
Single	9,999,999
Extended	2147483646 *

\* Note that this is a theoretical limit – Datamine process boundary limits will restrict this. Under 32-bit Windows, the total memory address space is 2GB.

### Datamine Special Values

Datamine has a number of fixed values that are used to represent specific values within the software. The value of 1.0e+30 was originally chosen to match standards other than IEEE and is used in both single and extended precision Datamine files.

Symbol/Name	Representation	Value
+	Top ( ceiling value)	1.0e+30
-	Absent (smallest value)	-1.0e30
tr	Trace (small value not zero)	1.0e-30



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