

Chapter 882

Fractional Factorial Designs

Introduction

This program generates two-level fractional-factorial designs of up to sixteen factors with blocking. Reports show the aliasing pattern that is used. The design rows may be output in standard or random order. The design data generated by this procedure can be produced in a spreadsheet as well as the output window.

When generating a design, the program first checks to see if the design is among those listed on page 410 of Box, Hunter, and Hunter (1978). If the requested design is not listed in the above book, the design pattern is determined using the standard procedure in which the highest-order interactions are confounded first, and so on. The procedure creates the design such that main effects are not aliased with each other.

An introduction to experimental design is presented in Chapter 881 on Two-Level Factorial Designs and will not be repeated here.

Procedure Options

This section describes the options available in this procedure.

Design Tab

This panel specifies the parameters that will be used to create the design values.

Experimental Setup

Runs

The desired size (number of rows) of the experiment. This number must be a power of two. This number determines what fraction of a complete replicate is run. For example, suppose you are contemplating an experiment with seven factors and have budget for sixteen runs. A full replication would take $2^7 = 128$ runs. Hence, this design is a 1/8th rep (note that $16/128 = 1/8$).

Block Size

The number of experiments (runs) per block. This determines the number of blocks. This number must be a power of 2 (2, 4, 8, 16, etc.). Of course, the block size must be less than or equal to one half the number of runs.

Fractional Factorial Designs

Sort Order

The order of the generated rows. The rows may be in random or standard order.

- **Random**

The rows are randomly ordered (random blocks and random rows within blocks). Use this option when the order of application to experimental units is governed by the row number.

- **Standard**

The rows are not randomly ordered. Instead, they are placed in standard order. Use this option when you want to quickly see the structure of the design.

Experimental Setup – Factor Values

Factor Values

Each factor has two possible values (levels) which are specified here. These are the values that will be written to the database. The first value is used to represent the low value. The second value represents the high value. You may use both text and numeric values.

The number of variables created depends on how many of these boxes have values in them.

Data Storage to Spreadsheet

Block Column

The column to contain the block identification numbers. The blocks are numbered from one to B, where B is the number of blocks. This column is optional. If this option is left blank, no blocks will be generated.

First Factor Column

This is where the group of columns that is to contain your design begins. The K-1 columns after this column are also filled with data. The number of columns used is determined by the number of Factor Values boxes that contain data.

Warning: The program fills these columns with data, so any previous data will be lost.

Reports Tab

These options designate the variables to contain the design and the values that will be placed in those variables.

Select Reports

Design Info Report

Specifies whether to display this report.

Aliases Report

Specifies whether to display this report.

Report Options

Aliases

One of the reports shows the confounding pattern among the columns of the design. However, when several factors are confounded, the number of terms aliased with each other gets very large. This option lets you limit the amount of information that the program displays.

Example 1 – Fractional Factorial Design

This section presents an example of how to generate an experimental design using this program. **CAUTION: since the purpose of this routine is to generate data, any existing data will be replaced. For this reason, you should begin with an empty output spreadsheet.**

In this example, we will show you how to generate a six-factor design using sixteen runs separated in blocks of four runs each.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Fractional Factorial Designs** procedure window by expanding **Design of Experiments**, then clicking on **Experimental Design**, and then clicking on **Fractional Factorial Designs**. You may then make the appropriate entries as listed below, or open **Example 1** by going to the **File** menu and choosing **Open Example Template**.

1 Specify the design parameters.

- On the Fractional Factorial Designs window, select the **Design tab**.
- Select **16** in the **Runs** box.
- Select **4** in the **Block Size** box.
- Select **Standard** in the **Sort Order** box.
- Set the first **six** of the **Factor Values** boxes equal to **-1 1**.
- Check the **Store Data on Spreadsheet** box.
- Enter **1** in the **Block Column** box.
- Enter **2** in the **First Factor Column** box.

2 Run the procedure.

- From the Run menu, select **Start Calculation**. Alternatively, just click the Calculate button.

Design Information Section

Design Information Section

Design:

1/4 replication of 6 factors in 4 blocks of 4 experiments.

Defining Contrast:

$i = ABCE = BCDF = ADEF$

Design Construction:

Generate a reduced model of the factors [A B C D].

The remaining factors are aliased with interactions of this reduced model as follows:

$E = ABC$

$F = BCD$

Blocking Section**Block:**

Blocks were generated by confounding them with the following interactions from the reduced model:

ABCD, CD

This report provides technical information about the design that was generated.

Fractional Factorial Designs

Aliases Section

One-Factor Aliases Section

A+BCE+ABCD+DEF
 B+ACE+CDF+ABDEF
 C+ABE+BDF+ACDEF
 D+ABCDE+BCF+AEF
 E+ABC+BCDEF+ADF
 F+ABCEF+BCD+ADE

Two-Factor Interaction Aliases Section

AB+CE+ACDF+BDEF
 AC+BE+ABDF+CDEF
 AD+BCDE+ABCF+EF
 AE+BC+ABCDEF+DF
 AF+BCEF+ABCD+DE
 BC+AE+DF+ABCDEF
 BD+ACDE+CF+ABEF
 BE+AC+CDEF+ABDF
 BF+ACEF+CD+ABDE
 CD+ABDE+BF+ACEF
 CE+AB+BDEF+ACDF
 CF+ABEF+BD+ACDE
 DE+ABCD+BCEF+AF
 DF+ABCDEF+BC+AE
 EF+ABCF+BCDE+AD

This report lists the aliases of the main effects and low-order interactions. The number of aliases listed is controlled by the Aliases Shown option.

From the first line of the report, we find that factor A (factor 1) is confounded with interactions BCE, DEF, and ABCDF. If any of the three-factor interactions are known to be real, this design would not be useful. Note that no two-factor interactions (like AB or CD) are aliased with the main effects.

1/4 Rep of a Six-Factor Design in Blocks of 4 Runs

Experimental Design

Row	Block	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1	1	1	1	-1	-1	-1	1
2	1	1	1	1	1	1	1
3	1	-1	-1	1	1	1	-1
4	1	-1	-1	-1	-1	-1	-1
5	2	1	-1	-1	-1	1	-1
6	2	1	-1	1	1	-1	-1
7	2	-1	1	-1	-1	1	1
8	2	-1	1	1	1	-1	1
9	3	-1	1	-1	1	1	-1
10	3	1	-1	-1	1	1	1
11	3	1	-1	1	-1	-1	1
12	3	-1	1	1	-1	-1	-1
13	4	1	1	1	-1	1	-1
14	4	-1	-1	1	-1	1	1
15	4	1	1	-1	1	-1	-1
16	4	-1	-1	-1	1	-1	1

The block and factor values were also produced on the spreadsheet.

These values are also generated on the spreadsheet.