

## Chapter 883

# Balanced Incomplete Block Designs

## Introduction

This module generates balanced incomplete block designs. Designs for up to ten treatments are available.

In order to make precise measurements of treatment means, uniform experimental conditions should be maintained when comparing a number of treatments. This ensures that differences among the treatment means result from the application of the treatment and not from some extraneous factor. To achieve this, experimental trials are often grouped together into blocks. In such designs, conditions are kept constant within the blocks and allowed to vary between the blocks. The best-known design of this type is the *randomized block* design. In this design, all treatments are present in each block.

Occasionally, the size of convenient blocks will not accommodate all the treatments of interest. For example, suppose you wanted to test four types of automobile tires for wear. An obvious choice for a block would be an automobile. You might select ten automobiles for the study. Assuming that the tires were rotated among the four positions, this experiment would control for differences in tire wear due to the type of automobile and the terrain that each traveled. However, blocking difficulties arise if you want to test six types of tires. You could redesign the automobile, or you could adopt a *balanced incomplete block* design.

In a balanced incomplete block design, the treatments are assigned to the blocks so that every pair of treatments occurs together in a block the same number of times. This achieves the *balance* that is described in the title of the procedure. The balance means that all differences between treatments are measured with equal precision.

Following is an example of how four treatments are assigned to blocks with a natural size of three experimental units. Four blocks are required for this balanced incomplete block design.

<b>Block</b>	<b>Treatment</b>
1	A B C
2	A B D
3	A C D
4	B C D

Note that each treatment occurs three times in this experimental layout. Also note that each pair of treatments occurs twice. These are the basic properties of the balanced incomplete designs.

Box, Hunter, and Hunter (1978) point out the following rules when using such designs.

1. Randomly assign the numbers to the blocks.
2. Randomly assign the letters to the treatments.
3. Randomly assign the treatments within the blocks.
4. Randomly group blocks as replicates. A replicate is a complete set of all treatments.

## Balanced Incomplete Block Designs

If you take these steps, this design can be used effectively in those situations in which the block size and the number of treatments do not match.

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

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## Design Limits

The designs used in this procedure were taken from Cochran and Cox (1992). We have included designs with up to ten treatments. The following table shows what block sizes are available for each number of treatments.

<b><u>Number of Treatments</u></b>	<b><u>Block Sizes Available</u></b>
4	2, 3
5	2, 3, 4
6	2, 3, 4, 5
7	2, 3, 4, 6
8	2, 4, 7
9	2, 4, 5, 6, 8
10	2, 3, 4, 5, 6, 9

Note that some block sizes are not available for certain numbers of treatments.

## Example 1 – Balanced Incomplete Block Design

This section presents an example of how to generate a balanced incomplete block design using this program. **CAUTION: since the purpose of this routine is to generate data, you should always begin with an empty output spreadsheet.**

In this example, we will show you how to generate a design with four treatments in blocks of two experimental units each.

### Setup

If the procedure window is not already open, use the PASS Home window to open it. The parameters for this example are listed below and are stored in the **Example 1** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

```
Design Tab
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Block Size .....2
Treatment Values .....1 2 3 4
Store Data on Spreadsheet .....Checked
Store First Factor In .....1
```

### Output

Click the Calculate button to perform the calculations and generate the following output.

#### BIBD with Four Treatments in Blocks of Two

##### Experimental Design

Row	Block	Treatment
1	1	1
2	1	2
3	2	3
4	2	4
5	3	1
6	3	3
7	4	2
8	4	4
9	5	1
10	5	4
11	6	2
12	6	3

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