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Creating and Customizing High-Impact Excel Workbooks from SAS with ODS EXCEL

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ABSTRACT

Love it or hate it, Microsoft Excel is used extensively throughout the business world. As a SAS user, you can enhance the impact of your work by using the ODS EXCEL destination to create high-quality, customized output in Excel format directly from SAS. This paper walks through a series of examples demonstrating the flexibility and power of this approach. In addition to complete control over visual attributes such as fonts, colors, and borders, the ODS EXCEL destination allows the SAS user to take advantage of Excel features such as multiple tabs, frozen or hidden rows and columns, and even Excel formulas to deliver the high-impact results you and your customers want!

OVERVIEW OF THE OUTPUT DELIVERY SYSTEM

Before SAS introduced the Output Delivery System, the traditional SAS listing was the primary mechanism by which the SAS system displayed output to the user. While this arrangement served its purpose, it had several limitations. Since it was designed at a time when line printers were widely used, it used a monospace typeface in which characters could be neatly arranged in rows and columns. It did not allow for the use of colors, fonts, graphics, and other visual elements commonly used today. The listing output could also be difficult to import into other applications.

To overcome these limitations and facilitate the creation of publication-quality output, SAS developed the Output Delivery System (ODS). It has been part of the base SAS product since version 7. No separate license is required to access this functionality.

ODS provides extensive flexibility for customizing SAS output:

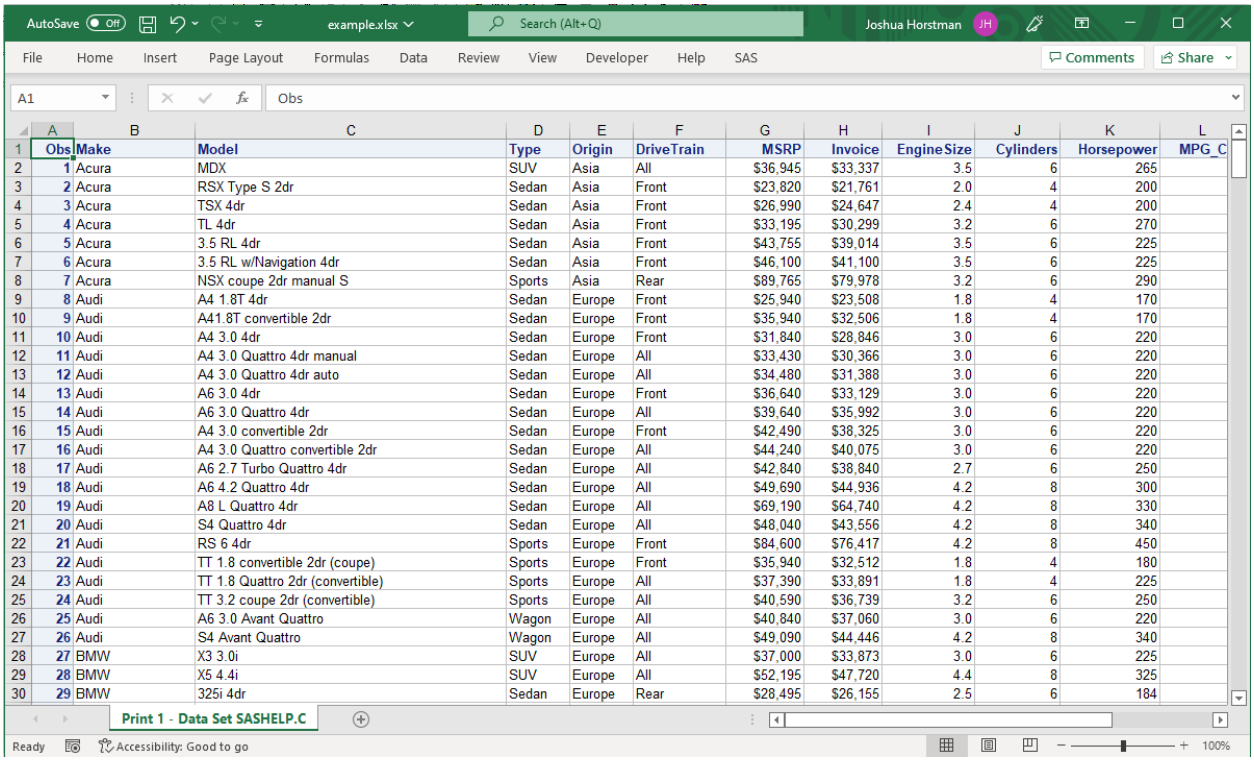
- Output can be created in a variety of common file formats (including Microsoft Excel files).
- Colors, fonts, borders, shading, and other visual elements can be incorporated.
- Graphics, images, links, and tables can be embedded.
- Pagination can be precisely controlled.
- Accessible output can be generated that will work with assistive technology.

In order to allow output to be created in many different file formats, ODS introduces the concept of a "destination." An ODS destination is simply a representation of a location and format to which output can be routed. Some commonly used ODS destinations include RTF, HTML, PDF, POWERPOINT, and EXCEL. Traditional SAS listing output is also still available through the LISTING destination. This paper will focus exclusively on the use of the ODS EXCEL destination.

USING THE ODS EXCEL DESTINATION

The ODS EXCEL destination creates native XLSX files, just like the files created by modern versions of Microsoft Excel. To create such a file using SAS, simply include a pair of ODS EXCEL statements (sometimes referred to as the "ODS sandwich") around the SAS code which generates the desired output. The first ODS EXCEL statement opens the EXCEL destination and directs the output to a specific file location using the FILE= option, while the second statement closes the destination using the CLOSE option. For example, the following sequence of statements directs the output from the PRINT procedure to the external Microsoft Excel file shown in Figure 1.

```
ods excel file="c:\example.xlsx";
proc print data=sashelp.cars; run;
ods excel close;
```



Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsepower	MPG_C
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	6	265	
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0	4	200	
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	4	200	
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	6	270	
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	6	225	
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	6	225	
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	6	290	
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	4	170	
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	4	170	
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0	6	220	
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0	6	220	
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0	6	220	
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0	6	220	
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0	6	220	
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0	6	220	
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3.0	6	220	
17	Audi	A6 2.7 Turbo Quattro 4dr	Sedan	Europe	All	$42,840	$38,840	2.7	6	250	
18	Audi	A6 4.2 Quattro 4dr	Sedan	Europe	All	$49,690	$44,936	4.2	8	300	
19	Audi	A8 L Quattro 4dr	Sedan	Europe	All	$69,190	$64,740	4.2	8	330	
20	Audi	S4 Quattro 4dr	Sedan	Europe	All	$48,040	$43,556	4.2	8	340	
21	Audi	RS 6 4dr	Sports	Europe	Front	$84,600	$76,417	4.2	8	450	
22	Audi	TT 1.8 convertible 2dr (coupe)	Sports	Europe	Front	$35,940	$32,512	1.8	4	180	
23	Audi	TT 1.8 Quattro 2dr (convertible)	Sports	Europe	All	$37,390	$33,891	1.8	4	225	
24	Audi	TT 3.2 coupe 2dr (convertible)	Sports	Europe	All	$40,590	$36,739	3.2	6	250	
25	Audi	A6 3.0 Avant Quattro	Wagon	Europe	All	$40,840	$37,060	3.0	6	220	
26	Audi	S4 Avant Quattro	Wagon	Europe	All	$49,090	$44,446	4.2	8	340	
27	BMW	X3 3.0i	SUV	Europe	All	$37,000	$33,873	3.0	6	225	
28	BMW	X5 4.4i	SUV	Europe	All	$52,195	$47,720	4.4	8	325	
29	BMW	325i 4dr	Sedan	Europe	Rear	$28,495	$26,155	2.5	6	184	

Figure 1. ODS Excel output from the PRINT Procedure

THE ODS EXCEL OPTIONS OPTION

The ODS EXCEL statement has an OPTIONS option that allows the user to specify a variety of Excel-specific sub-options. One or more pairs of sub-options and values can be enclosed in parentheses after the OPTIONS keyword as follows:

```
ods excel file="c:\example.xlsx"
      options(suboption1=value1 suboption2=value2);
```

The next several examples demonstrate the use of some of the sub-options available using the OPTIONS option. An exhaustive list of the available sub-options can be found in *SAS® 9.4 Output Delivery System: User's Guide, Fifth Edition* (2016).

SPECIFYING THE WORKSHEET NAME

An Excel workbook consists of one or more worksheets, each of which has a name. By default, the worksheets in an Excel workbook created using the ODS EXCEL destination will be named automatically by SAS. However, if a particular worksheet name is desired, it can be specified using the SHEET_NAME sub-option of the OPTIONS option.

The following code prints the SASHELP.CARS dataset to an Excel worksheet named "My CARS Output" as displayed in Figure 2.

```
ods excel file="c:\example.xlsx"
      options(sheet_name="My CARS Output");
proc print data=sashelp.cars; run;
ods excel close;
```

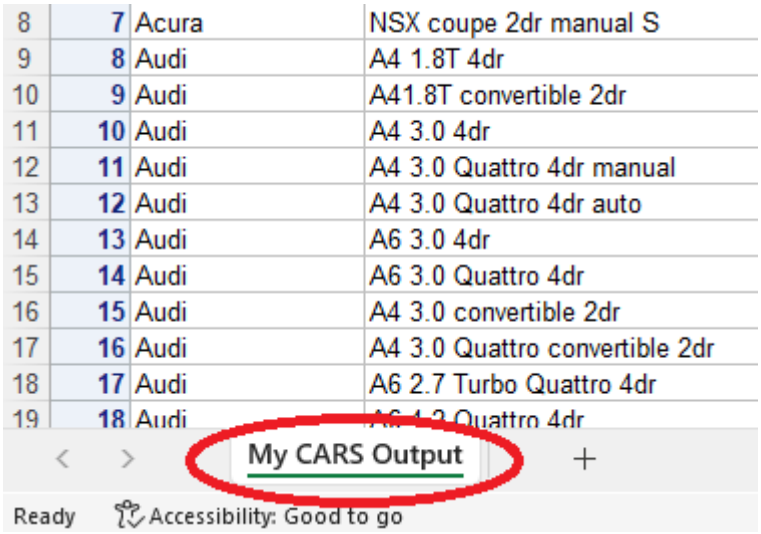


Figure 2. Specifying the Worksheet Name

CREATING MULTIPLE WORKSHEETS WITH BY GROUPS

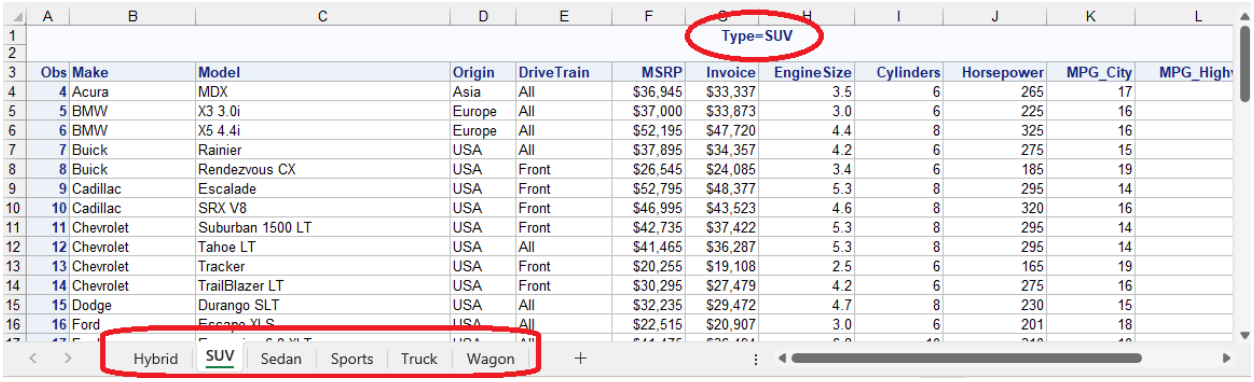
Many SAS procedures support BY group processing using the BY statement. This is conceptually similar to running the procedure separately for each BY group. When BY group processing is used in conjunction with the ODS EXCEL destination, a separate worksheet is created within the Excel workbook for each unique value of the BY variable (or each unique combination of values when there are multiple BY variables).

The naming of the individual worksheet tabs generated during BY group processing can be controlled using the #BYVALn syntax within the SHEET_NAME sub-option described in the previous example. For example, if #BYVAL1 were used, it would be replaced in each worksheet name with the value of the first BY variable. Similarly, #BYVAL2 would be replaced with the value of the second BY variable, if any.

Of course, in order to use BY group processing, the input dataset must be sorted (or indexed) by the BY variable(s). The following example uses the SORT procedure to sort the data before opening the ODS EXCEL destination and invoking PROC PRINT to create the output seen in Figure 3.

```
proc sort data=sashelp.cars out=cars;
  by type make model;
run;

ods excel file="c:\example.xlsx"
      options(sheet_name="#byval1");
proc print data=cars;
   by type;
run;
ods excel close;
```



	Obs	Make	Model	Origin	DriveTrain	MSRP	Invoice	Engine Size	Cylinders	Horsepower	MPG_City	MPG_High
4	4	Acura	MDX	Asia	All	$36,945	$33,337	3.5	6	265	17	
5	5	BMW	X3 3.0i	Europe	All	$37,000	$33,873	3.0	6	225	16	
6	6	BMW	X5 4.4i	Europe	All	$52,195	$47,720	4.4	8	325	16	
7	7	Buick	Rainier	USA	All	$37,895	$34,357	4.2	6	275	15	
8	8	Buick	Rendezvous CX	USA	Front	$26,545	$24,085	3.4	6	185	19	
9	9	Cadillac	Escalade	USA	Front	$52,795	$48,377	5.3	8	295	14	
10	10	Cadillac	SRX V8	USA	Front	$46,995	$43,523	4.6	8	320	16	
11	11	Chevrolet	Suburban 1500 LT	USA	Front	$42,735	$37,422	5.3	8	295	14	
12	12	Chevrolet	Tahoe LT	USA	All	$41,465	$36,287	5.3	8	295	14	
13	13	Chevrolet	Tracker	USA	Front	$20,255	$19,108	2.5	6	165	19	
14	14	Chevrolet	TrailBlazer LT	USA	Front	$30,295	$27,479	4.2	6	275	16	
15	15	Dodge	Durango SLT	USA	All	$32,235	$29,472	4.7	8	230	15	
16	16	Ford	Escape XLS	USA	All	$22,515	$20,907	3.0	6	201	18	

Figure 3. Multiple Worksheets with BY Groups

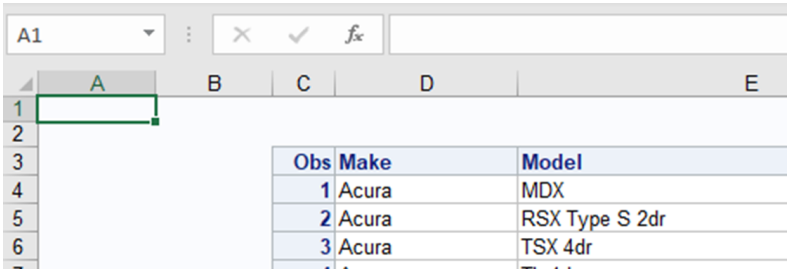
The value(s) of the BY variable(s) will also appear at the top of each worksheet as a header line in the first row of the spreadsheet. To suppress this header, invoke the NOBYLINE option on the global OPTIONS statement (not to be confused with the OPTIONS option on the ODS EXCEL statement).

```
options nobyline;
```

SPECIFYING A START LOCATION

By default, any SAS output created using the ODS EXCEL destination will begin in the upper-left corner of the Excel worksheet, which Excel designates as cell A1. To place the output in a different location in the worksheet, use the START_AT sub-option in the OPTIONS option to specify a different cell. The following code would start the output in cell C3 instead. Output is shown in Figure 4.

```
ods excel file="c:\example.xlsx" options(start_at="C3");
proc print data=sashelp.cars; run;
ods excel close;
```



	Obs	Make	Model
1	1	Acura	MDX
2	2	Acura	RSX Type S 2dr
3	3	Acura	TSX 4dr

Figure 4. Specifying a Start Location

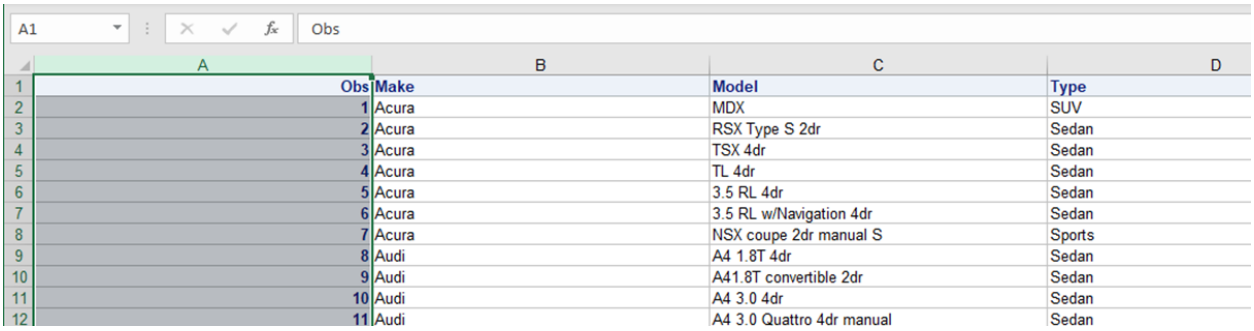
ADJUSTING COLUMN WIDTHS AND ROW HEIGHTS

ODS automatically determines the width for each column in the Excel worksheet based on the lengths of the values and/or labels being placed in that column. You can manually specify the column widths in a couple of different ways. If you wish to specify different widths for different columns, this can be accomplished using in-line styling, which is discussed later in this paper.

However, if you simply wish to specify a common width for all columns in the workbook, this can be done with the ABSOLUTE_COLUMN_WIDTH sub-option on the OPTIONS option. The width can be specified using any ODS-supported unit (cm, mm, in, px, etc.). If you omit the units, the width value will translate directly into Excel's default width units which represent a specific number of characters in the default font.

The following ODS EXCEL statement sets the column width to 3 inches. Output is shown in Figure 5.

```
ods excel file="c:\example.xlsx"
      options(absolute_column_width="3in");
proc print data=sashelp.cars; run;
ods excel close;
```

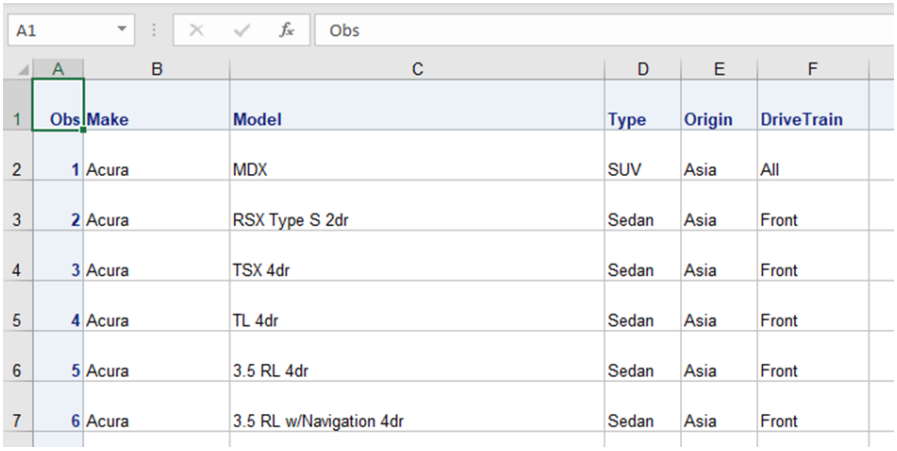


	A	B	C	D
1	Obs	Make	Model	Type
2	1	Acura	MDX	SUV
3	2	Acura	RSX Type S 2dr	Sedan
4	3	Acura	TSX 4dr	Sedan
5	4	Acura	TL 4dr	Sedan
6	5	Acura	3.5 RL 4dr	Sedan
7	6	Acura	3.5 RL w/Navigation 4dr	Sedan
8	7	Acura	NSX coupe 2dr manual S	Sports
9	8	Audi	A4 1.8T 4dr	Sedan
10	9	Audi	A41.8T convertible 2dr	Sedan
11	10	Audi	A4 3.0 4dr	Sedan
12	11	Audi	A4 3.0 Quattro 4dr manual	Sedan

Figure 5. Adjusting Absolute Column Width

Similarly, to change the height of all rows in an Excel worksheet, use the ABSOLUTE_ROW_HEIGHT sub-option. Output is shown in Figure 6.

```
ods excel file="c:\example.xlsx"
      options(absolute_row_height="30");
proc print data=sashelp.cars; run;
ods excel close;
```

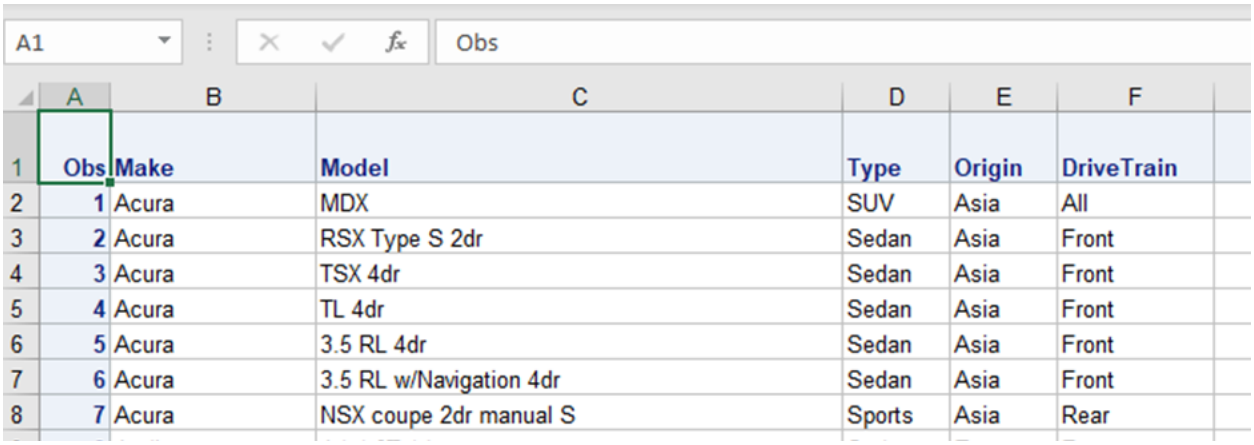


	A	B	C	D	E	F
1	Obs	Make	Model	Type	Origin	DriveTrain
2	1	Acura	MDX	SUV	Asia	All
3	2	Acura	RSX Type S 2dr	Sedan	Asia	Front
4	3	Acura	TSX 4dr	Sedan	Asia	Front
5	4	Acura	TL 4dr	Sedan	Asia	Front
6	5	Acura	3.5 RL 4dr	Sedan	Asia	Front
7	6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front

Figure 6. Adjusting Absolute Row Height

If you wish to specify a height for the header row that is different from the rest of the rows, use the ROW_HEIGHTS sub-option and provide the header row height followed by a comma and then the body row height. Figure 7 displays the result.

```
ods excel file="c:\example.xlsx"
      options(row_heights="30,15");
proc print data=sashelp.cars; run;
ods excel close;
```



	A	B	C	D	E	F
1	Obs	Make	Model	Type	Origin	DriveTrain
2	1	Acura	MDX	SUV	Asia	All
3	2	Acura	RSX Type S 2dr	Sedan	Asia	Front
4	3	Acura	TSX 4dr	Sedan	Asia	Front
5	4	Acura	TL 4dr	Sedan	Asia	Front
6	5	Acura	3.5 RL 4dr	Sedan	Asia	Front
7	6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front
8	7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear

Figure 7. Adjusting Row Heights

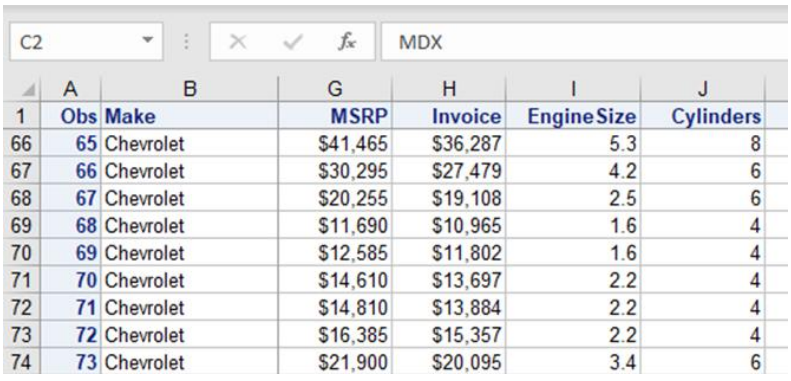
HIDING OR FREEZING ROWS AND COLUMNS

The extensive functionality provided by Microsoft Excel includes the ability to hide individual or multiple rows and/or columns as well as to freeze header rows and/or columns. Hidden rows or columns still exist in the spreadsheet but simply are not visible until unhidden. Frozen header rows or columns are locked in place and always remain visible as the rest of the spreadsheet is scrolled in any direction.

Both features can be accessed using the ODS EXCEL statement. To hide specific rows and/or columns, use the HIDDEN_ROWS and/or HIDDEN_COLUMNS sub-options to specify the row or column number of the row or column to be hidden. To hide multiple rows or columns, list all the numbers separated by commas. To freeze header rows or columns, use the FROZEN_ROWHEADERS and/or FROZEN_HEADERS sub-options to specify the number of rows and/or columns to be frozen. For example, if the FROZEN_HEADERS sub-option is given a value of “1” then only the top row will be frozen whereas a value of “3” would result in the first three rows all being frozen.

The following code creates an Excel worksheet having the first two rows and the first column (column A) frozen. The resulting output in Figure 8 has been scrolled both down and to the right but the first two rows and the first column always remain visible.

```
ods excel file="c:\example.xlsx"
     options(
          frozen_headers="1"
          frozen_rowheaders="2");
proc print data=sashelp.cars; run;
ods excel close;
```

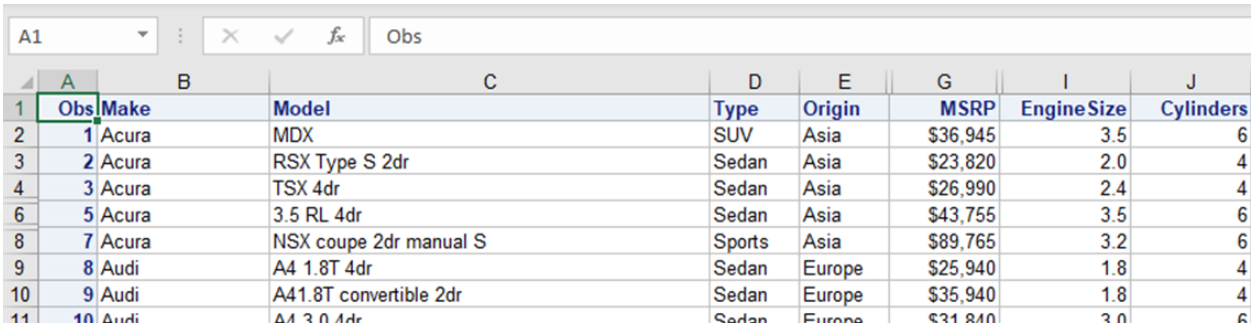


	A	B	G	H	I	J
1	Obs	Make	MSRP	Invoice	EngineSize	Cylinders
66	65	Chevrolet	$41,465	$36,287	5.3	8
67	66	Chevrolet	$30,295	$27,479	4.2	6
68	67	Chevrolet	$20,255	$19,108	2.5	6
69	68	Chevrolet	$11,690	$10,965	1.6	4
70	69	Chevrolet	$12,585	$11,802	1.6	4
71	70	Chevrolet	$14,610	$13,697	2.2	4
72	71	Chevrolet	$14,810	$13,884	2.2	4
73	72	Chevrolet	$16,385	$15,357	2.2	4
74	73	Chevrolet	$21,900	$20,095	3.4	6

Figure 8. Frozen Headers and Row Headers

Similarly, the following code creates the Excel worksheet shown in Figure 9 having the 5th and 7th rows and 6th and 8th columns (that is, columns F and H) hidden.

```
ods excel file="c:\example.xlsx"
     options(
          hidden_rows="5,7"
          hidden_columns="6,8");
proc print data=sashelp.cars; run;
ods excel close;
```



A1 | Obs

	A	B	C	D	E	G	I	J
1	Obs	Make	Model	Type	Origin	MSRP	EngineSize	Cylinders
2	1	Acura	MDX	SUV	Asia	$36,945	3.5	6
3	2	Acura	RSX Type S 2dr	Sedan	Asia	$23,820	2.0	4
4	3	Acura	TSX 4dr	Sedan	Asia	$26,990	2.4	4
6	5	Acura	3.5 RL 4dr	Sedan	Asia	$43,755	3.5	6
8	7	Acura	NSX coupe 2dr manual S	Sports	Asia	$89,765	3.2	6
9	8	Audi	A4 1.8T 4dr	Sedan	Europe	$25,940	1.8	4
10	9	Audi	A41.8T convertible 2dr	Sedan	Europe	$35,940	1.8	4
11	10	Audi	A4 3.0 4dr	Sedan	Europe	$31,840	3.0	6

Figure 9. Hidden Row and Columns

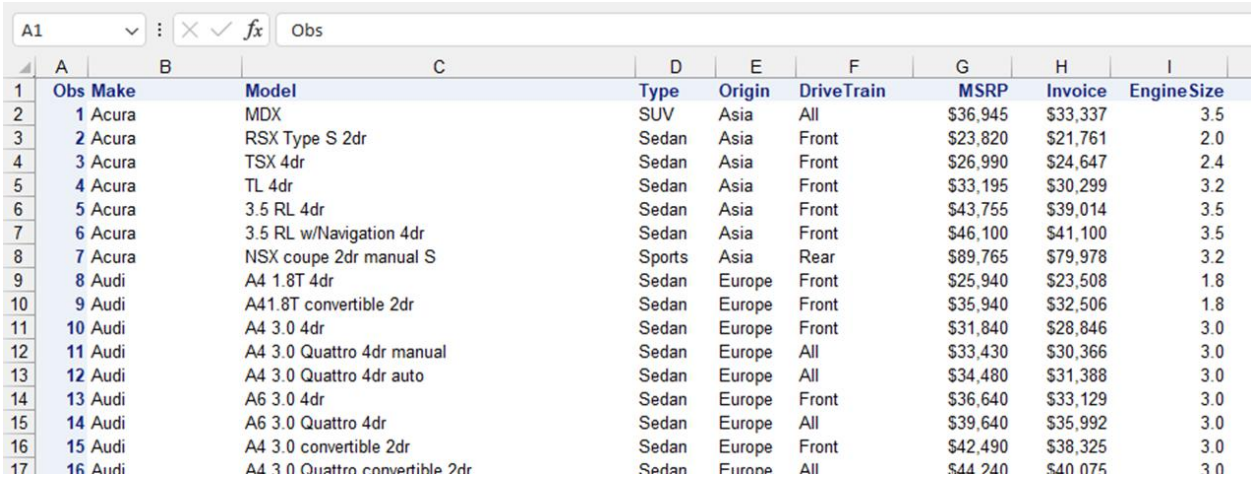
REMOVING OR MODIFYING CELL BORDERS

Another feature provided by the ODS EXCEL destination is the ability to remove or modify the Excel worksheet cell borders. Unfortunately, this is not available as a sub-option on the OPTIONS option. Rather, we must create a custom style using the TEMPLATE procedure and then apply that style on the ODS EXCEL statement. Custom styles are discussed in more detail later in this paper.

To remove the cell borders from the worksheet, use the following code to create a custom style which derives from the built-in style named STYLES.EXCEL but has the BORDERSTYLE attribute set to HIDDEN. The classes DATA, HEADER, and ROWHEADER are included so that this style modification will be applied to all areas of the output as shown in Figure 10.

Note the use of the ODS PATH statement to ensure that this custom style can be found when it is applied using the STYLE= option on the ODS EXCEL statement.

```
ods path(prepend) work.templat(update);
proc template;
  define style styles.mystyle;
    parent=styles.excel;
    class data, header, rowheader / borderstyle=hidden;
  end;
run;
ods excel file="c:\example.xlsx" style=styles.mystyle;
proc print data=sashelp.cars; run;
ods excel close;
```

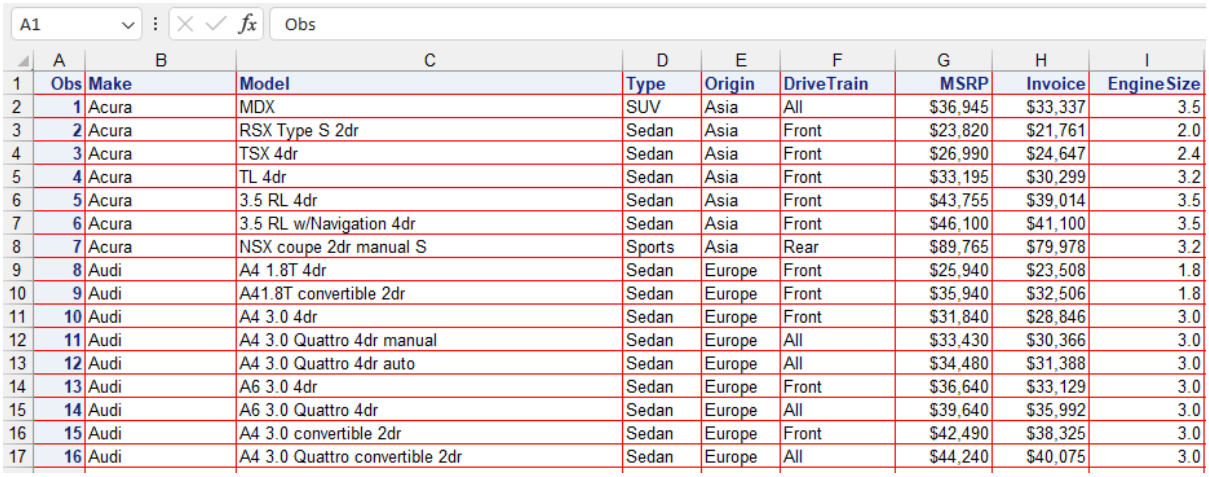


Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3.0

Figure 10. Removing the Cell Borders

As an alternative, to modify the appearance of the cell borders, change the values of the BORDERSTYLE, BORDERWIDTH, and/or BORDERCOLOR attributes as desired. The example below creates the Excel worksheet displayed in Figure 11 with solid red cell borders that are 3 pixels in thickness.

```
ods path(prepend) work.templat(update);
proc template;
  define style styles.mystyle;
    parent=styles.excel;
    class data, header, rowheader /
      borderstyle=solid
      borderwidth=3px
      bordercolor=red;
  end;
run;
ods excel file="c:\example.xlsx" style=styles.mystyle;
proc print data=sashelp.cars; run;
ods excel close;
```



Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3.0

Figure 11. Modifying the Cell Borders

CREATING EXCEL FORMULAS FROM SAS

Formulas are one of the most powerful features of Excel, and the ODS EXCEL destination provides a way to build Excel formulas directly from SAS. In general, ODS EXCEL will format any character data as a text string in Excel. However, if the FORMULAS sub-option of the OPTIONS option is set to "YES" then any string beginning with an equal sign will be interpreted as an Excel formula.

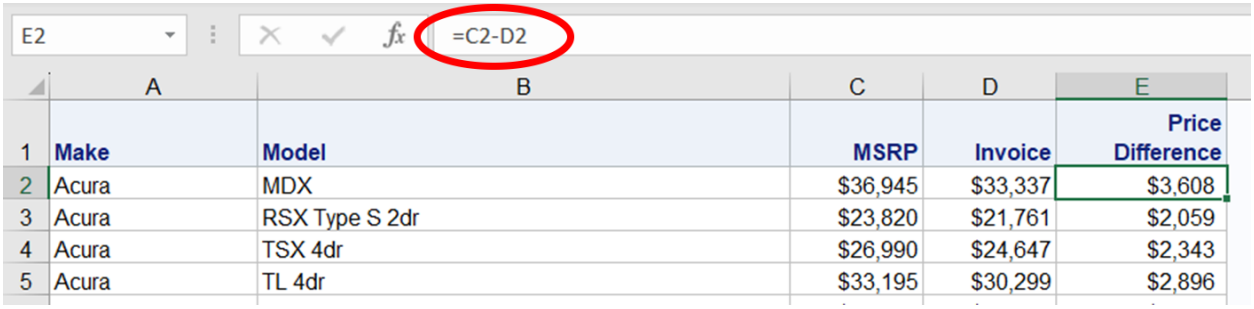
To make use of this functionality, it is incumbent upon the programmer to utilize the tools available within SAS to construct the desired Excel formula. In the following example, the SASHELP.CARS dataset is pre-processed in a DATA step to add a new character variable called PRICEDIFF. This variable contains an Excel formula constructed using the CATS function. The formula computes the difference between the variables MSRP (found in column C of the Excel output) and INVOICE (found in column D).

```
data cars;
  set sashelp.cars;
  pricediff = cats("=C",_n_+1,"-D",_n_+1);
run;
```

Next, we use the PRINT procedure on the resulting WORK.CARS dataset, directing the output to the ODS EXCEL destination. The FORMULAS sub-option is set to "YES" so that the text found in PRICEDIFF will be interpreted as Excel formulas. Note that some additional in-line styling is applied to PRICEDIFF so that it will be right-justified and will have the appropriate Excel formatting applied so that it will be rendered as a dollar amount.

```
ods excel file="c:\example.xlsx" options(formulas="YES");
proc print data=cars noobs label;
  label pricediff="Price Difference";
  var make model msrp invoice ;
  var pricediff / style={just=r tagattr='format:$#,##0_)'};
run;
ods excel close;
```

The output is shown in Figure 12 with cell E2 selected. The formula bar at the top shows that this cell contains a live Excel formula, not a static value.



	A	B	C	D	E
1	Make	Model	MSRP	Invoice	Price Difference
2	Acura	MDX	$36,945	$33,337	$3,608
3	Acura	RSX Type S 2dr	$23,820	$21,761	$2,059
4	Acura	TSX 4dr	$26,990	$24,647	$2,343
5	Acura	TL 4dr	$33,195	$30,299	$2,896

Figure 12. Creating Excel Formulas from SAS

OUTPUT FROM MULTIPLE PROCEDURES

Earlier we discussed how to create a separate worksheet (or tab) within an Excel workbook (file) for each BY group within the output from a single procedure. We can also create multiple worksheets by running multiple procedures. By default, output from each SAS procedure is written to a separate worksheet. We can individually customize the attributes of each worksheet using additional ODS EXCEL statements. The following example creates two separate worksheets, each with a specific color and name as shown in Figure 13.

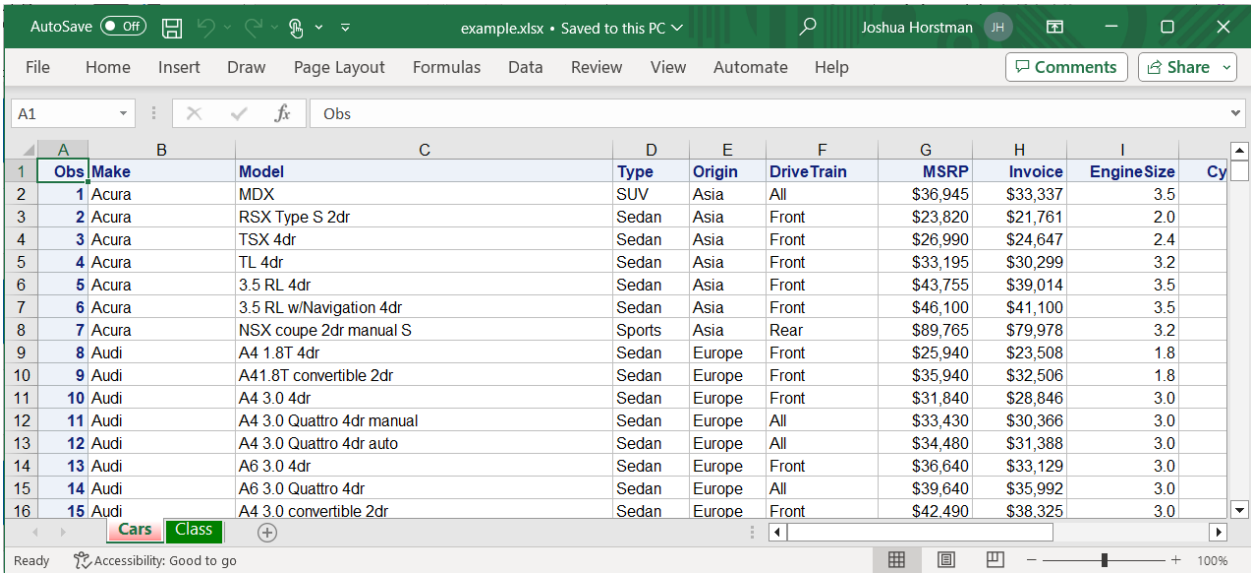
```
ods excel file="c:\msug\example.xlsx"
          options(tab_color="red" sheet_name="Cars");

proc print data=sashelp.cars; run;

ods excel options(tab_color="green" sheet_name="Class");

proc print data=sashelp.class; run;

ods excel close;
```



Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cy
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0	
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0	
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0	
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0	
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0	
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0	
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0	

Figure 13. Output from Multiple Procedures

MULTIPLE PROCEDURES WITH BY GROUPS

Running multiple procedures using BY group processing results by default in a separate worksheet for each BY group for each procedure. For example, running three procedures using BY group processing with six BY groups would result in an Excel workbook having 18 worksheets.

If this is not desirable, it is possible to create an Excel workbook in which all the procedure output for a given BY group is placed together in a single worksheet so that the workbook contains just one worksheet per BY group. In the following example, we accomplish this by taking manual control of BY group processing using the SAS Macro Language.

The code is placed within a macro definition so that can make use of a macro %DO loop. The first step is to use the SQL procedure to create a series of macro variables containing the unique values of the BY variable. In this example, we use the SASHELP.CARS dataset with TYPE as the BY variable. The macro variables are named TYPE1, TYPE2, etc. We also create one additional macro variable, NUMTYPES, containing the number of unique values of TYPE, which happens to be 6.

```
%macro create_xlsx;

  proc sql noprint;
    select distinct(type) into :type1-
      from sashelp.cars
```

```
    order by type;
  %let numtypes = &sqlobs;
quit;
```

Next, we disable the automatic titles generated by each SAS procedure and open the ODS EXCEL destination. The SHEET_INTERVAL sub-option on the OPTIONS option is set to “NONE”. This causes all procedure output to be directed to the same worksheet until we indicate otherwise.

```
ods noproctitle;
ods excel file="c:\example.xlsx"
    options(sheet_interval='none' embedded_titles='on');
```

We then invoke a macro %DO loop which executes once for each unique value of TYPE. During each iteration, the Excel worksheet name is set to match the current value of TYPE. Next, a single title is added to identify the current value of TYPE.

Then, the MEANS, FREQ, and SGPLOT procedures are called. However, no BY statement is used. Instead, the input dataset is subset using a WHERE statement so that only the records for the current value of TYPE are processed.

Once all three procedures have been run, the ODS EXCEL statement is invoked with the SHEET_INTERVAL sub-option set to “NOW” to indicate that the next procedure output should be written to a new worksheet.

```
%do i = 1 %to &numtypes;
  ods excel options(sheet_name="&&type&i");
  title "Vehicle Type = &&type&i";
  proc means data=sashelp.cars;
    where type = "&&type&i";
    var horsepower;
  run;
  title;
  proc freq data=sashelp.cars;
    where type = "&&type&i";
    tables origin;
  run;
  proc sgplot data=sashelp.cars;
    where type = "&&type&i";
    reg x=weight y=enginesize;
  run;
  ods excel options(sheet_interval='now');
%end;
```

Finally, once the %DO loop has completed, the Excel file is closed. This ends the macro definition. The macro must then be executed to produce the output shown in Figure 14.

```
  ods excel close;
%mend create_xlsx;

%create_xlsx;
```

Refer to Horstman (2020) for a more detailed explanation of utilizing sets of macro variables in this manner to create dynamic programs that execute code independently for each unique value (or combination of values) of a specific variable (or group of variables) without hardcoding those values.

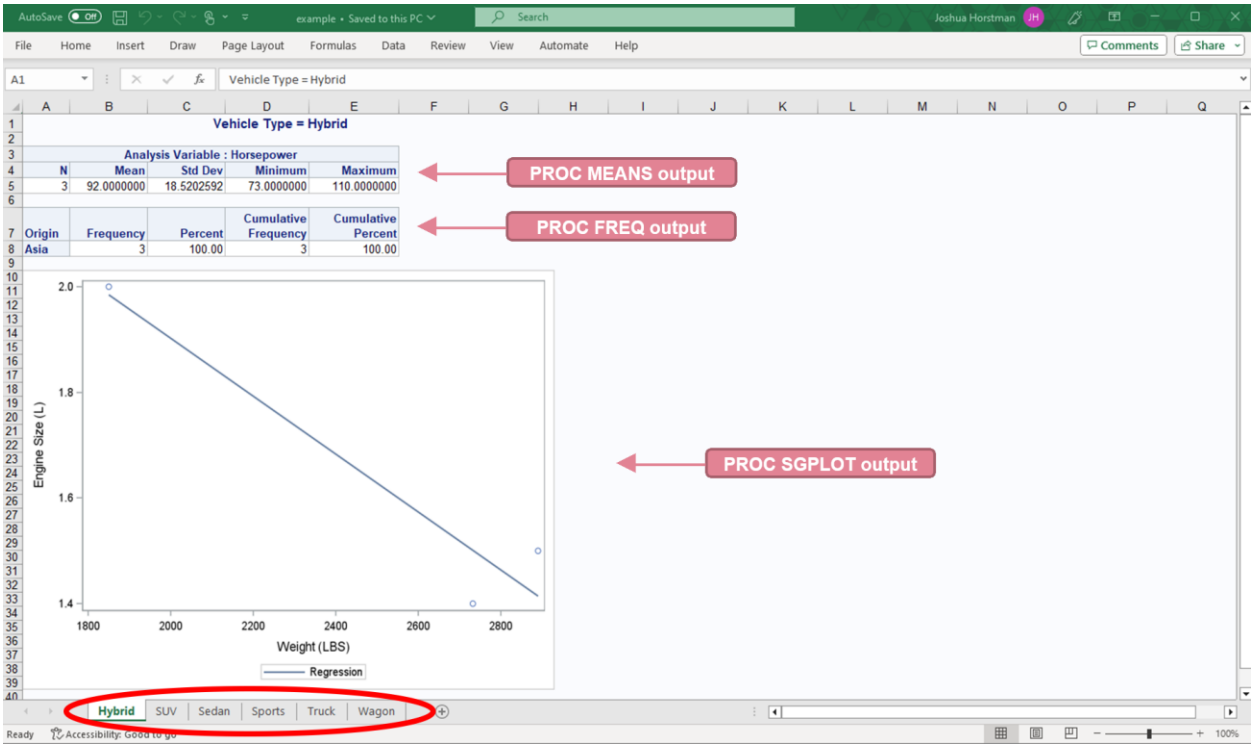


Figure 14. Multiple Procedures with BY Groups

WORKING WITH DATES AND TIMES

SAS and Microsoft Excel use different methods to represent date and time values. SAS stores dates as the number of days since January 1, 1960, while Microsoft Excel instead counts the days since January 1, 1900.

Times in SAS are represented by the number of seconds since midnight, while Excel converts the time of day into a decimal value representing the fraction of a day that would have passed at that clock time. In other words, Excel stores noon as 0.5 (halfway through the day) and SAS stores noon as 43,200.

When creating an Excel spreadsheet using the ODS EXCEL destination that includes date and/or time values, it's important to make sure that these values are correctly converted. To do this, simply be sure that an appropriate date or time format is applied in SAS to any variables which are used in your Excel output. Unformatted values will not convert correctly since ODS EXCEL will be unaware of what they represent.

CUSTOMIZING ODS EXCEL OUTPUT WITH STYLES

The previous section described how to create an Excel workbook directly from SAS using the ODS EXCEL destination and how to modify some basic properties and features of the resulting Excel file. ODS styles take this one step further by providing rich functionality for the complete customization of nearly every aspect of the appearance of your Excel workbook. This includes colors, fonts, borders, backgrounds, and much more. We will briefly discuss three ways to access this functionality: built-in styles, custom styles, and in-line styling.

USING BUILT-IN STYLES

The SAS system includes a library of built-in styles that are ready for use. Each of these styles represents a complete set of visual attributes that can be applied to any ODS output, whether that's an Excel spreadsheet or another ODS destination. Some of the built-in styles that are included with SAS are listed below:

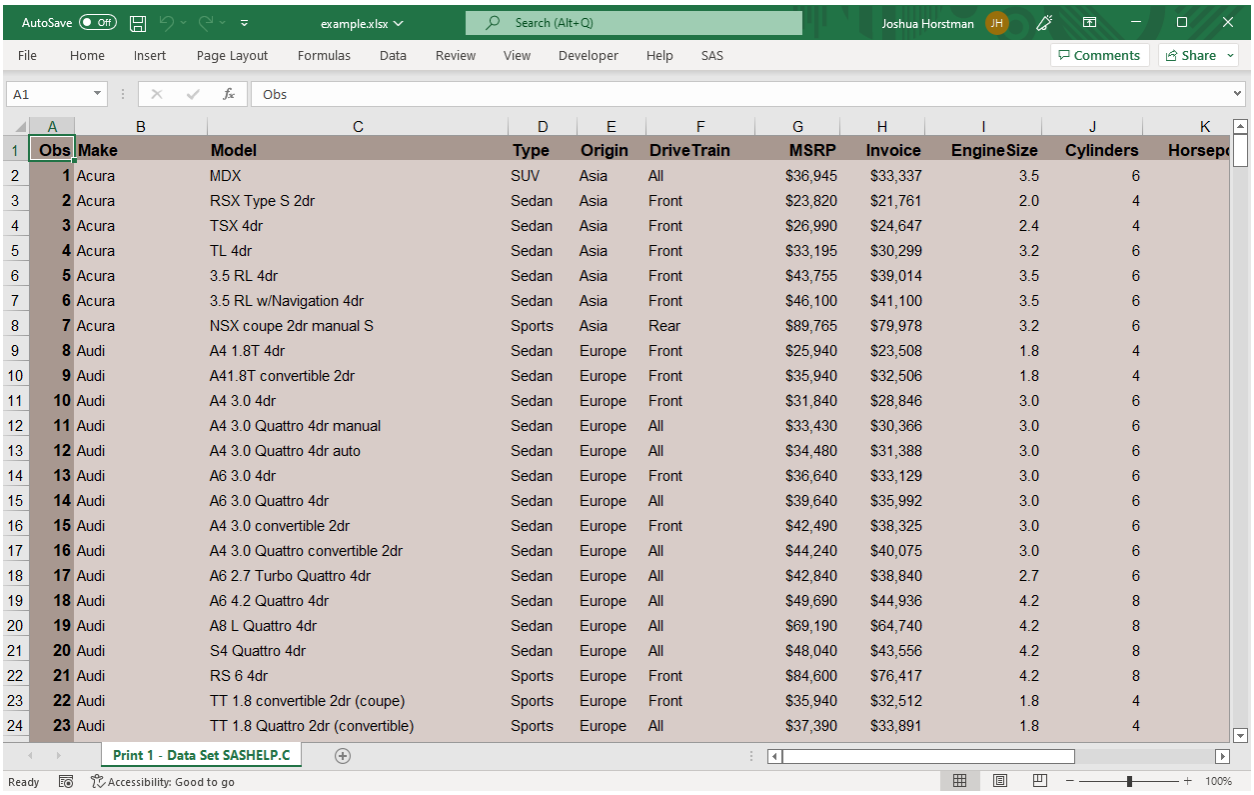
- STYLES.BANKER
- STYLES.BRICK
- STYLES.HARVEST
- STYLES.OCEAN
- And many more…

These built-in styles are stored in the SASHELP.TMPLMST item store. To see a list of available built-in styles, submit the following PROC TEMPLATE code:

```
proc template;
   path sashelp.tmplmst;
   list styles;
run;
```

To apply one of these styles to Excel output generated through the ODS EXCEL destination, utilize the STYLE= option on the ODS EXCEL statement when opening the destination. The following example prints the SASHELP.CARS dataset using the STYLES.BROWN style as shown in Figure 15.

```
ods excel file="c:\example.xlsx" style=styles.brown;
proc print data=sashelp.cars; run;
ods excel close;
```



Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsep
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	6	
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0	4	
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	4	
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	6	
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	6	
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	6	
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	6	
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	4	
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	4	
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0	6	
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0	6	
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0	6	
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0	6	
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0	6	
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0	6	
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3.0	6	
17	Audi	A6 2.7 Turbo Quattro 4dr	Sedan	Europe	All	$42,840	$38,840	2.7	6	
18	Audi	A6 4.2 Quattro 4dr	Sedan	Europe	All	$49,690	$44,936	4.2	8	
19	Audi	A8 L Quattro 4dr	Sedan	Europe	All	$69,190	$64,740	4.2	8	
20	Audi	S4 Quattro 4dr	Sedan	Europe	All	$48,040	$43,556	4.2	8	
21	Audi	RS 6 4dr	Sports	Europe	Front	$84,600	$76,417	4.2	8	
22	Audi	TT 1.8 convertible 2dr (coupe)	Sports	Europe	Front	$35,940	$32,512	1.8	4	
23	Audi	TT 1.8 Quattro 2dr (convertible)	Sports	Europe	All	$37,390	$33,891	1.8	4	

Figure 15. Using Built-in Styles

CREATING YOUR OWN STYLES

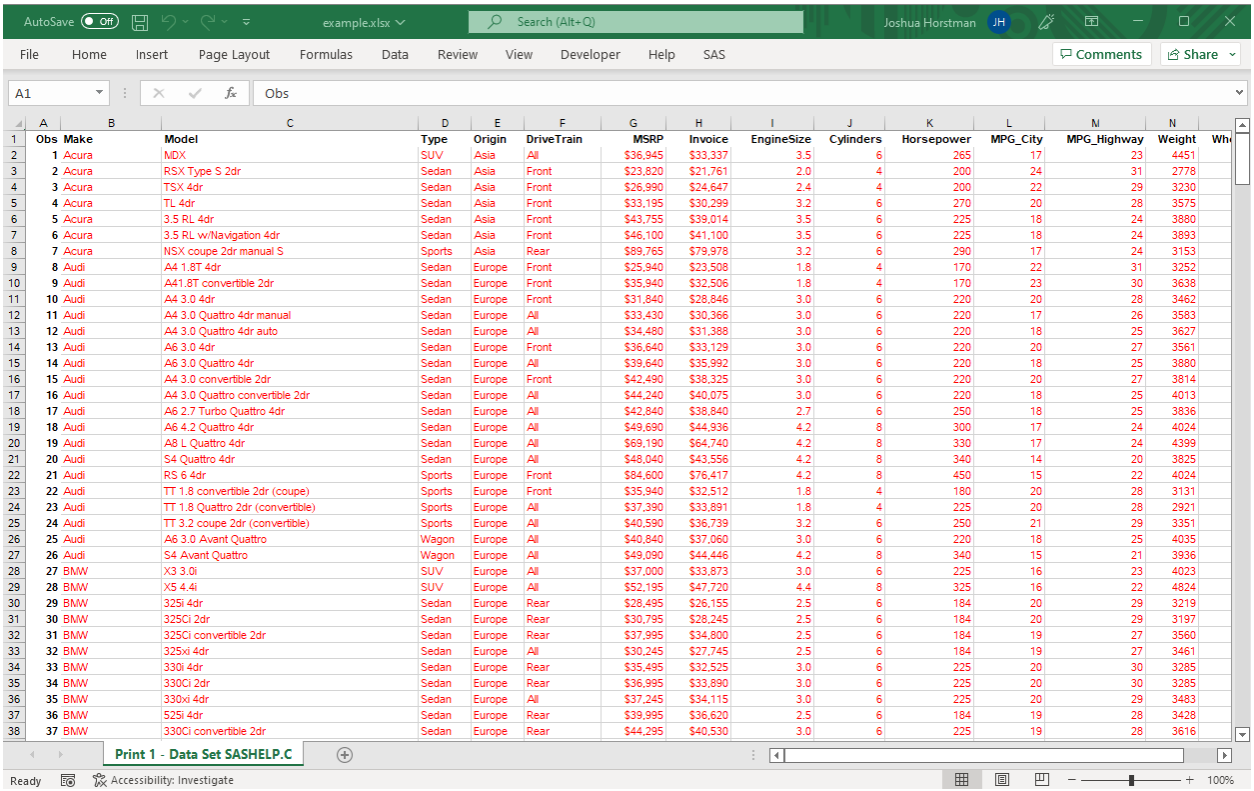
In addition to using the wide variety of built-in styles described above, ODS also allows you to define your own custom styles using PROC TEMPLATE. This gives you the flexibility to specify the values of each of the different visual attributes that control every aspect of how your Excel output appears.

You can either create a new style completely from scratch, or you can start with an existing style and modify it as desired. The following PROC TEMPLATE code creates a new style called STYLES.MYSTYLE which inherits the properties of the built-in style STYLES.PEARL and changes the value of a single attribute.

```
proc template;
     define style styles.mystyle;
          parent = styles.pearl;
          class data / color=red;
     end;
run;
```

This style can then be applied to ODS EXCEL output as before to produce the result in Figure 16.

```
ods excel file="c:\example.xlsx" style=styles.mystyle;
proc print data=sashelp.cars; run;
ods excel close;
```



Obs	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	EngineSize	Cylinders	Horsepower	MPG_City	MPG_Highway	Weight
1	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	6	265	17	23	4451
2	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2.0	4	200	24	31	2778
3	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	4	200	22	29	3230
4	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	6	270	20	28	3575
5	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	6	225	18	24	3880
6	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	6	225	18	24	3893
7	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	6	290	17	24	3153
8	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	4	170	22	31	3252
9	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	4	170	23	30	3638
10	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3.0	6	220	20	28	3462
11	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3.0	6	220	17	26	3583
12	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3.0	6	220	18	25	3627
13	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3.0	6	220	20	27	3561
14	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3.0	6	220	18	25	3880
15	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3.0	6	220	20	27	3814
16	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3.0	6	220	18	25	4013
17	Audi	A6 2.7 Turbo Quattro 4dr	Sedan	Europe	All	$42,840	$38,840	2.7	6	250	18	25	3836
18	Audi	A6 4.2 Quattro 4dr	Sedan	Europe	All	$49,690	$44,936	4.2	8	300	17	24	4024
19	Audi	A8 L Quattro 4dr	Sedan	Europe	All	$69,190	$64,740	4.2	8	330	17	24	4399
20	Audi	S4 Quattro 4dr	Sedan	Europe	All	$48,040	$43,556	4.2	8	340	14	20	3825
21	Audi	RS 6 4dr	Sports	Europe	Front	$84,600	$76,417	4.2	8	450	15	22	4024
22	Audi	TT 1.8 convertible 2dr (coupe)	Sports	Europe	Front	$35,940	$32,512	1.8	4	180	20	28	3131
23	Audi	TT 1.8 Quattro 2dr (convertible)	Sports	Europe	All	$37,390	$33,891	1.8	4	225	20	28	2921
24	Audi	TT 3.2 coupe 2dr (convertible)	Sports	Europe	All	$40,590	$36,739	3.2	6	250	21	29	3351
25	Audi	A6 3.0 Avant Quattro	Wagon	Europe	All	$40,840	$37,060	3.0	6	220	18	25	4035
26	Audi	S4 Avant Quattro	Wagon	Europe	All	$49,090	$44,446	4.2	8	340	15	21	3936
27	BMW	X3 3.0i	SUV	Europe	All	$37,000	$33,873	3.0	6	225	16	23	4023
28	BMW	X5 4.4i	SUV	Europe	All	$52,195	$47,720	4.4	8	325	16	22	4824
29	BMW	325i 4dr	Sedan	Europe	Rear	$28,495	$26,155	2.5	6	184	20	29	3219
30	BMW	325Ci 2dr	Sedan	Europe	Rear	$30,795	$28,245	2.5	6	184	20	29	3197
31	BMW	325Ci convertible 2dr	Sedan	Europe	Rear	$37,995	$34,800	2.5	6	184	19	27	3560
32	BMW	325xi 4dr	Sedan	Europe	All	$30,245	$27,745	2.5	6	184	19	27	3461
33	BMW	330i 4dr	Sedan	Europe	Rear	$35,495	$32,525	3.0	6	225	20	30	3285
34	BMW	330Ci 2dr	Sedan	Europe	Rear	$36,995	$33,890	3.0	6	225	20	30	3285
35	BMW	330xi 4dr	Sedan	Europe	All	$37,245	$34,115	3.0	6	225	20	29	3483
36	BMW	525i 4dr	Sedan	Europe	Rear	$39,995	$36,620	2.5	6	184	19	28	3428
37	BMW	330Ci convertible 2dr	Sedan	Europe	Rear	$44,295	$40,530	3.0	6	225	19	28	3616

Figure 16. Creating a User-Defined Style

PROC TEMPLATE is a complex procedure with an extensive array of available classes, elements, and attributes. Detailed information can be found in the PROC TEMPLATE documentation in *SAS 9.4 Output Delivery System: Procedures Guide, Third Edition* (2016), or refer to Smith (2013) for a thorough treatment of the topic.

USING IN-LINE STYLING

The final way to employ ODS styles is using in-line styling. In-line styling provides a convenient way to override the appearance of individual elements of your output without the need to use PROC TEMPLATE to create a complete style template. This is done by specifying one or more pairs of attributes and values using the STYLE= option, which is available on specific statements in various procedures including the PRINT, REPORT, and TABULATE procedures, among others.

Within PROC REPORT, in-line styling can be applied to several different report locations. These locations are named COLUMN, HEADER, SUMMARY, REPORT, LINES, and CALLDEF. Selecting one of these locations allows you to control which portions of the report output will be affected by the in-line style. If a location is not specified, the in-line style will be applied to a default location. The default location is different depending on which PROC REPORT statement contains the in-line style.

Statement	Default Location
PROC REPORT	REPORT
DEFINE	COLUMN and HEADER
BREAK / RBREAK	SUMMARY and LINES
COMPUTE	LINES

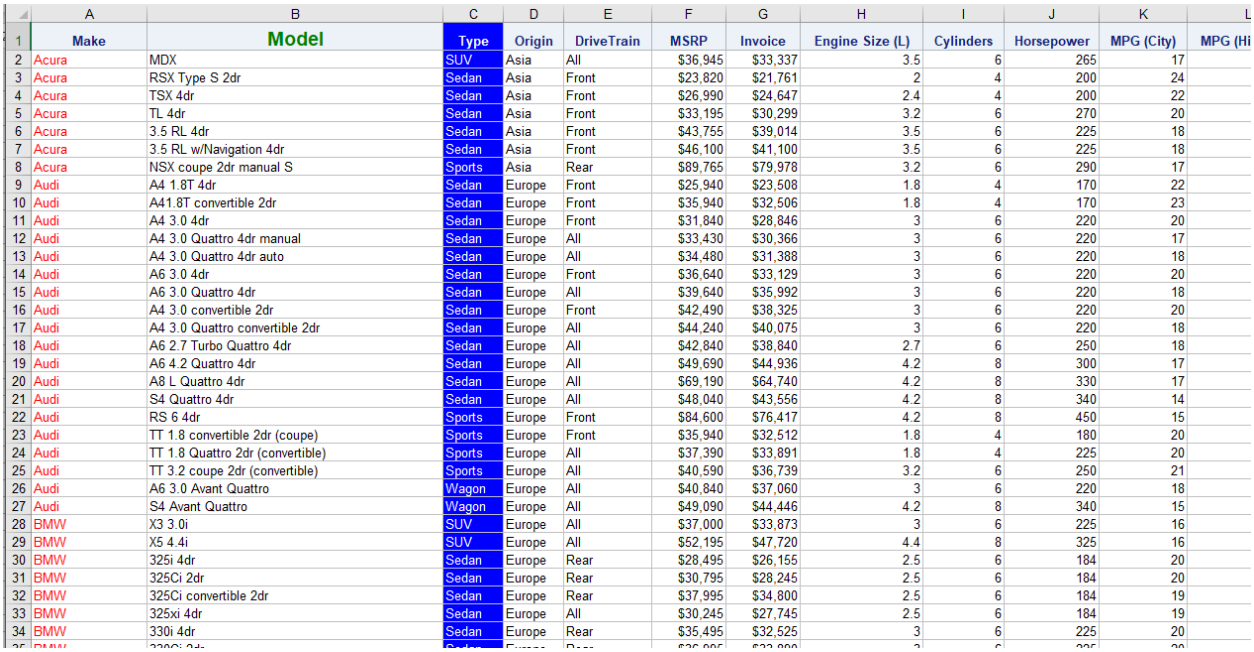
The following PROC REPORT code shows how in-line styling can be applied to modify various attributes in various report locations. The output is directed to an Excel spreadsheet using the ODS EXCEL destination, but the same PROC REPORT code could have been used with most other ODS destinations as well. The resulting output is shown in Figure 17.

```
ods excel file="c:\example.xlsx";

proc report data=sashelp.cars
      style(report)=[cellpadding=3px];
  define make / style(column)=[color=red];
  define model/ style(header)=[color=green font_size=14pt];
  define type / style=[background_color=blue color=white];
run;

ods excel close;
```

Refer to Eslinger (2018) for a thorough explanation of customizing PROC REPORT output using ODS styles.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	Engine Size (L)	Cylinders	Horsepower	MPG (City)	MPG (Hi
2	Acura	MDX	SUV	Asia	All	$36,945	$33,337	3.5	6	265	17	
3	Acura	RSX Type S 2dr	Sedan	Asia	Front	$23,820	$21,761	2	4	200	24	
4	Acura	TSX 4dr	Sedan	Asia	Front	$26,990	$24,647	2.4	4	200	22	
5	Acura	TL 4dr	Sedan	Asia	Front	$33,195	$30,299	3.2	6	270	20	
6	Acura	3.5 RL 4dr	Sedan	Asia	Front	$43,755	$39,014	3.5	6	225	18	
7	Acura	3.5 RL w/Navigation 4dr	Sedan	Asia	Front	$46,100	$41,100	3.5	6	225	18	
8	Acura	NSX coupe 2dr manual S	Sports	Asia	Rear	$89,765	$79,978	3.2	6	290	17	
9	Audi	A4 1.8T 4dr	Sedan	Europe	Front	$25,940	$23,508	1.8	4	170	22	
10	Audi	A41.8T convertible 2dr	Sedan	Europe	Front	$35,940	$32,506	1.8	4	170	23	
11	Audi	A4 3.0 4dr	Sedan	Europe	Front	$31,840	$28,846	3	6	220	20	
12	Audi	A4 3.0 Quattro 4dr manual	Sedan	Europe	All	$33,430	$30,366	3	6	220	17	
13	Audi	A4 3.0 Quattro 4dr auto	Sedan	Europe	All	$34,480	$31,388	3	6	220	18	
14	Audi	A6 3.0 4dr	Sedan	Europe	Front	$36,640	$33,129	3	6	220	20	
15	Audi	A6 3.0 Quattro 4dr	Sedan	Europe	All	$39,640	$35,992	3	6	220	18	
16	Audi	A4 3.0 convertible 2dr	Sedan	Europe	Front	$42,490	$38,325	3	6	220	20	
17	Audi	A4 3.0 Quattro convertible 2dr	Sedan	Europe	All	$44,240	$40,075	3	6	220	18	
18	Audi	A6 2.7 Turbo Quattro 4dr	Sedan	Europe	All	$42,840	$38,840	2.7	6	250	18	
19	Audi	A6 4.2 Quattro 4dr	Sedan	Europe	All	$49,690	$44,936	4.2	8	300	17	
20	Audi	A8 L Quattro 4dr	Sedan	Europe	All	$69,190	$64,740	4.2	8	330	17	
21	Audi	S4 Quattro 4dr	Sedan	Europe	All	$48,040	$43,556	4.2	8	340	14	
22	Audi	RS 6 4dr	Sports	Europe	Front	$84,600	$76,417	4.2	8	450	15	
23	Audi	TT 1.8 convertible 2dr (coupe)	Sports	Europe	Front	$35,940	$32,512	1.8	4	180	20	
24	Audi	TT 1.8 Quattro 2dr (convertible)	Sports	Europe	All	$37,390	$33,891	1.8	4	225	20	
25	Audi	TT 3.2 coupe 2dr (convertible)	Sports	Europe	All	$40,590	$36,739	3.2	6	250	21	
26	Audi	A6 3.0 Avant Quattro	Wagon	Europe	All	$40,840	$37,060	3	6	220	18	
27	Audi	S4 Avant Quattro	Wagon	Europe	All	$49,090	$44,446	4.2	8	340	15	
28	BMW	X3 3.0i	SUV	Europe	All	$37,000	$33,873	3	6	225	16	
29	BMW	X5 4.4i	SUV	Europe	All	$52,195	$47,720	4.4	8	325	16	
30	BMW	325i 4dr	Sedan	Europe	Rear	$28,495	$26,155	2.5	6	184	20	
31	BMW	325Ci 2dr	Sedan	Europe	Rear	$30,795	$28,245	2.5	6	184	20	
32	BMW	325Ci convertible 2dr	Sedan	Europe	Rear	$37,995	$34,800	2.5	6	184	19	
33	BMW	325xi 4dr	Sedan	Europe	All	$30,245	$27,745	2.5	6	184	19	
34	BMW	330i 4dr	Sedan	Europe	Rear	$35,495	$32,525	3	6	225	20	

Figure 17. Using In-Line Styling with PROC REPORT

CONCLUSION

The ODS EXCEL destination provides a powerful and flexible way to create Microsoft Excel workbooks directly from SAS. The use of ODS styles and the various ODS EXCEL options provides for extensive customization of nearly every aspect of the resulting output. This integration between SAS and Microsoft Excel allows one to have the best of both worlds – the power and functionality of the SAS system along with the flexibility and ubiquity of Microsoft Excel.

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