ABBYY FlexiCapture

A Guide to Creating Machine-Readable Forms

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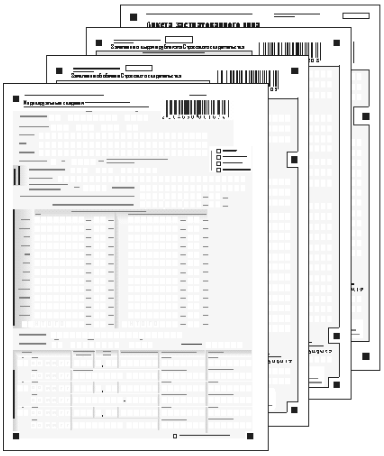
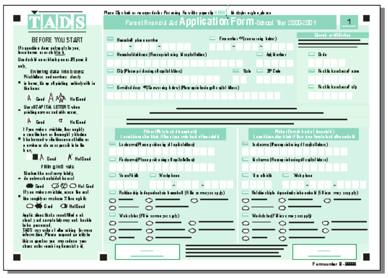
What is a Form?





Questionnaires, social security forms, polling slips, warranty cards are all different types of **form** used to collect different types of information.

How do forms differ from other types of documents?

1. A form always has a set number of fields

2. Each field may contain only a certain type of information, e.g. a "Last Name" field contains only last names (if completed correctly) and a "Date" field contains only dates.

Forms are used when information must be gathered from a large number of respondents. Manual information gathering is a long and tiresome process where typos and errors are almost inevitable, and machine–readable forms are used to automate this process.

Automated forms processing consists of the following stages:

1. Setting up the form–processing application (creating a template and specifying the fields to be recognized).

2. Acquiring form images (scanning).

3. Processing the form images (recognizing the images and validating the extracted data).

4. Exporting the extracted data to an external information system.

Automated forms processing is most effective on forms that meet certain requirements which are discussed in this chapter.

Machine–Readable Forms

To be able to read information on the forms, a form–processing application must do the following:

1. Determine the location of form elements.
2. Separate field contents from field borders, text marking, backgrounds, explanatory text, etc.

Machine–readable forms enable the program to carry out these tasks.
In order for the first task to be carried out successfully, **the forms must correspond to the form pattern or template**, i.e. the location of all form elements must be identical on all forms of the same type.
In order for the second task to be carried out successfully, **the forms must be designed with automated input in mind**, i.e. so that the program can easily distinguish between the data to be captured and such non–recognizable form elements as field borders, text marking, backgrounds, or explanatory text.

Form Completion Methods

A form may be completed in one of the following ways:

- by hand
- using a dot–matrix printer
- using a typewriter
- at a printing shop (here belong also forms completed using inkjet or laser printers with a resolution of no less than 300 dpi)
- using a combination of the above

Elements of Machine–Readable Forms

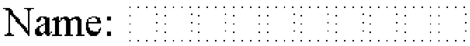
The following elements may be present on a form:

Text

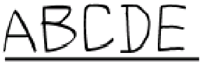
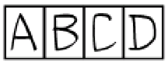
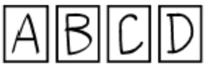
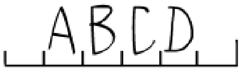
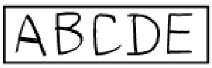
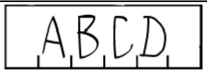
Text is an element of a machine–readable form that contains descriptive text: form title, field names, explanations, etc.

Entry Field

An **entry field** is an element of a machine–readable form into which text is entered by the person who completes the form. To facilitate text entry, entry fields may contain special text marking. Entry fields are usually accompanied by text that describes or explains the nature of the data to be entered.



Possible text marking types are listed in the table below.

Text over a Line	Text is entered over a line.	
Letters in Frames	Letters are entered into conjoined frames.	
Letters in Separate Frames	Letters are entered into isolated frames.	
Letters on a Comb	Letters are entered over a comb.	
Text in a Frame	Text is entered in a frame.	
Text in a Frame with a Comb	Text is entered in a frame with a comb.	

Checkmark Field

A **checkmark field** is an element of a machine–readable form (usually a square that is called a "check box") in which a mark should be made by the person who completes the form.
A checkmark field usually has an accompanying text which explains the use of the checkmark.

□ Subscribe to the news list

Possible shapes of checkmark fields are shown in the table below.

Square	Circle	Underline
□	○	▬

Other shapes are also possible, e.g. polygons, ovals, etc.

Checkmark Group

A **checkmark group** is an element of a machine–readable form that unites several checkmark fields of which only one must be checked. Checkmark groups are usually accompanied by explanatory text that explains the nature of the choice to be made

May is the month of which season: ○ winter ○ summer ○ spring ○ autumn

Reference Mark

A **reference mark** is an element of a machine–readable form that is used to facilitate the matching of form images with templates and to determine the orientation of forms during automated processing.
Before the program can start recognizing the contents of the form, it must match the form with its template. All machine–readable forms of the same type must conform to one template, i.e. the location of all form elements must be exactly the same on all forms. The program will attempt to match the form with its template relying on the number and location of the reference marks on the form. If the program manages to match the reference marks on the form with the reference marks on the template, it will know exactly where to look for fields containing data to be recognized.
Standard reference marks are listed in the table below.

Black Square	Corner	Cross	Timing Mark
■	┌	+	▬

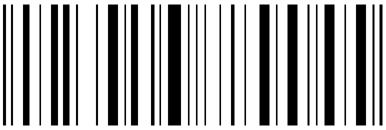
For best recognition results, it is advisable to have standard reference marks on the form, but in some cases line separators, explanatory text or barcodes can also be used as reference marks. However, standard reference marks are more reliable and should always be your first choice.

Line Separator

A **line separator** is an element of a machine–readable form in the shape of a vertical or horizontal black line.
Line separators are used for partitioning forms into several logical segments.

Form Identifier

A **form identifier** is an element of a machine–readable form that is used for selecting the right template if several templates have the same arrangement of reference marks.
We recommend using barcodes as form identifiers.
A barcode is a set of vertical black and white lines of differing widths used for encoding information.



Some other elements on the form can also be used as form identifiers.

Picture

A **picture** is an element of a machine–readable form that should not be recognized and should be exported as an image file.

For example, the part of the form where a stamp or signature should be put is a picture.

Table

A **table** contains columns with same-type elements.
Table columns can contain elements of the following types:

- text;
- entry field;
- date;
- number;
- checkmark.

A table can contain a line with column headers.

Group of elements

Group of elements – an element of a machine-readable form that serves to combine several logically linked elements in a group.

Types of Machine–Readable Form

Machine–readable forms **are designed with automated input in mind**, i.e. the program should be able to easily distinguish between the data to be captured and the non–recognizable form elements, such as field borders, text marking, backgrounds, or explanatory text.

This can be achieved in one of two ways:

1. The form must be designed in such a way as to make the field borders, background and text marking disappear after scanning, or
2. The form must be designed in such a way as to make the field borders, background and text marking stand out clearly after scanning.

If the first approach is used, only the reference marks, explanatory text, and entered data will remain on the form after scanning. As a result, the program will not have to separate the data from form elements, which will make recognition more easy and reliable.

In this case, the following types of forms are used: color dropout forms, black–and–white forms with raster backgrounds, black–and–white forms with raster borders, and black–and–white linear forms.

If the second approach is used, the reference marks, explanatory text, entered data, as well as text marking and field borders will remain on the form after scanning. The program will look for information that is surrounded by field borders and text marking. An absence of these form elements will have an adverse effect on the quality of recognition.
In this case, **black–and–white linear forms** are used.

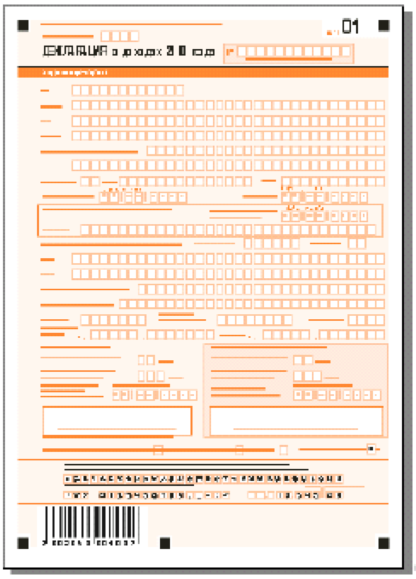
Dropout Forms

Dropout forms have a light color background with white rectangles serving as character cells, checkmark fields, etc.

For example, gray drop–out forms. Their background is gray.

Color drop–out forms include forms on which only element borders are colored.

A character cell is a small rectangle into which only one character should be entered (e.g. a letter or a digit). The color of the background is very important because it must disappear during scanning. The background is usually light red–orange or green. For the list of recommended colors, see in "**Recommended Colors for Dropout Forms**".



Ideally, all form elements, with the exception of the reference marks, should disappear during scanning, leaving only the field contents to be recognized on the form image.

Explanatory text can be either retained (if printed in black) or filtered out together with the background. For explanatory text to disappear during scanning, it must be printed in the same color as the form's background but with greater saturation.

When deciding whether to print explanatory text in black or in background color, the following should be taken into account:

- The size of the image file will be larger if the explanatory text is retained.
- There should be at least 1.5–2 mm of space between the explanatory text printed in black and other elements on the form. The gap between the explanatory text and the corresponding checkmark field must not be less than 2/3 of the size of the checkmark field. If the explanatory text is printed in background color, spaces between the text and other form elements are not so crucial.

Forms with explanatory text printed in black are more legible. We recommend printing explanatory text in black especially if there are no reference marks on the form.

💡 **Tip** When creating a template for a form with explanatory text printed in background color, be sure to scan the form in color or in grayscale mode to make the explanatory text and elements on the form clearly visible.

Dropout forms must be scanned using a color lamp or filter. The color of the lamp is selected depending on the color of the background.
Forms with red or green backgrounds must be scanned either:

- on a color scanner using color filtering software;
- on a non–color scanner using a red or green lamp (hardware color filtering);

- on a non–color scanning using a white lamp and a red or green filter (filtering quality in this case is much lower, as the background may not disappear completely, or field contents may be inadvertently removed); or
- on a non–color scanner using a white lamp without any filters.
  When scanning with a white lamp, some lighter backgrounds can be removed without filtering: the weak saturation of the background will ensure its disappearance during scanning. In this case, the color and saturation of the background must be selected by trial–and–error for each particular scanner.

📝 **Note.** Many color scanners also have software filtering used to filter out blue colors. However, we do not recommend using shades of blue on your forms, as forms are likely to be completed using not only black but also blue ink. Field contents written in blue ink will disappear in this case.

Choosing the Right Color

Red–orange colors are preferable to green because they represent the greatest possible contrast to blue, which results in better scanning and recognition quality if the forms are completed using blue ink.

In "**Recommended Colors for Dropout Forms**" you will find the recommended colors for form processing, i.e. those most likely to disappear during scanning with almost any scanner. A "dropout" color list for a particular scanner (in Pantone or any other format) can also be obtained from your scanner manufacturer/dealer.

Black–and–White Forms with Raster Backgrounds

Fields on such forms are simply white spaces (usually rectangles) on a raster background. The background is made up of individual dots. The recommended size of the dots is no more than 0.1 mm, with the distance between each dot about 1 mm. The size of the dots and distance between the dots are crucial, because a raster background is removed during despeckling rather than during scanning: the program will treat the dots as garbage and remove them. Consequently, the dots should not be glued together on scanned images.

Black–and–White Forms with Raster Borders

These forms have no background. All field borders (borders of character cells, checkmark fields and other form elements) are made up of raster lines, i.e. sequences of small black dots. Raster dot size is usually 0.39–0.5 pt. The recommended size is 0.39 pt, with the distance between the raster dots being at least five times larger than the dot size. The size of the dots and distance between the dots are crucial, because a raster background is removed during despeckling rather than during scanning: the program will treat the dots as garbage and remove them. Consequently, the dots should not be glued together on scanned images.

Black–and–White Linear Forms

These forms usually have no background. All field borders (character cells, checkmark fields and other form elements) are made up of solid black lines. Field borders do not disappear as a result of scanning or despeckling.

📝 **Note.** Forms of this type must be completed very neatly. If the forms are completed carelessly, letters may overlap the field borders, thus reducing recognition quality. This is because whenever the field content overlaps the field borders, it is extremely difficult for the application to separate the borders from the text. Ideally, the entered text should not touch upon the field borders.

Choosing the Right Type of Form

Besides the design and processing requirements for each type of form, other criteria also need to be taken into consideration when choosing a form type: printing costs and methods, the number of copies required, the resulting image size, scanning modes, the required degree of recognition accuracy, form processing speed, overall appearance of the forms, how neatly they will be completed, etc. The table below summarizes the advantages and disadvantages of each form type.

Criteria	**Dropout Form**		**Black–and–White Raster Form**		**Black–and–White Linear Form**	
	Disadvantage	**Advantage**	**Disadvantage**	**Advantage**	**Disadvantage**	**Advantage**
Design Complexity		Easy to design using any graphics editor.	Text editors offer limited tools for designing this type of form. The size of raster dots is crucial.			Easy to design using any graphics editor

Criteria	Dropout Form		Black–and–White Raster Form		Black–and–White Linear Form	
	Disadvantage	**Advantage**	**Disadvantage**	**Advantage**	**Disadvantage**	**Advantage**
Printing	Difficult to print large quantities of good quality forms in–house.			Easy to print in–house.		Easy to print in–house.
Printing Costs	If professional printing services are used, printing costs are higher compared with black–and–white forms.			If professional printing services are used, printing costs are lower compared with dropout forms.		If professional printing services are used, printing costs are lower compared with dropout forms
Image Size		Image file sizes are smaller.	Image file sizes are larger.		Image file sizes are larger.	
Scanning Mode	Only special scanning modes (color filtering) may be used.		Limited range of brightness and contrast settings.		Limited range of brightness and contrast settings.	
Processing Speed		Higher average processing speed.	Average processing time is longer, because the images need to be despeckled.		Errors are more likely if characters are glued together or overlap field borders.	
Recognition Quality		Very high recognition quality.		High recognition quality.	Recognition quality largely depends on how neatly the form has been filled out.	High recognition quality if the form has been filled out correctly.
Location of explanatory text		Explanatory text may be placed anywhere, including inside fields (as long it is printed using the same color as the form background).	Explanatory text and other form elements must be carefully arranged on the form.		Explanatory text and other form elements must be carefully arranged on the form.	
Form Appearance and Legibility	Low contrast settings of background and explanatory text may have an adverse effect on form legibility.	Aesthetically pleasing	Less eye–catching design. Lower legibility.		Less eye–catching design.	Good legibility.
Neatness of Completion		Less sensitive to text overlapping field borders.	Small characters must be written very carefully and be large enough not to be removed as garbage.	Less sensitive to text overlapping field borders.	Very sensitive to text overlapping field borders.	

General Requirements for Machine–Readable Forms

Let us now consider the general requirements a form must meet in order to be machine–readable.

Form Background

1. Use dropout forms or forms with raster field borders if possible.
2. Use a color that vanishes during scanning when creating a dropout form. See the list of recommended colors in "**Recommended Colors for Dropout Forms**".
3. Always ensure that a distance exists between the explanatory text and the field contents. In the case of dropout forms we recommend that any information be printed in the same color as the form background (except where explanatory text is used as a reference mark instead of or in conjunction with black squares). By printing information in the same color as the background, you are then free to place it anywhere on the form, including inside the form fields.
4. Do not use blue colors for forms which are to be completed by hand. The blue background may merge with the blue ink which is likely to be used to complete the forms, which will have an adverse effect on recognition quality.

Reference Mark

1. Standard reference marks are recommended for use on machine–readable forms (i.e. black squares, corners, Crosses). The recommended number of reference marks is five: four reference marks in each corner of the form (they should form a rectangle if imaginary lines are drawn between each pair) and one square on one of the sides of the imaginary rectangle.
2. If, for some reason, standard reference marks cannot be used, we recommend that the following combinations of elements be used as reference marks:
   a) at least two vertical line separators and two horizontal line separators
   b) at least four **text** elements and one **form identifier** element
   c) other combinations are also possible
3. The distance between the edge of a reference mark and the nearest form element should not be less than 3 mm.
4. The distance between a reference mark and the edge of the page should not be less than 8 mm.
5. Reference marks should be printed using a dark color (black is recommended) so that they do not disappear during scanning.

In addition to the general requirements listed above, each reference mark type has its own specific requirements:

Black Squares

Black squares on the same form type should all be of the same size i.e. between 4x4 mm and 8x8 mm. The recommended size is 5x5 mm. Rectangles are not permitted.

Crosses and Corners

1. The size of an imaginary square that could be drawn around a reference mark of this type must be within the range from 4x4 to 8x8 mm. The recommended size is 5x5 mm.
2. The size of reference marks of one type must be the same within one form.
3. All the sides of a reference mark must be of equal size.
4. The line thickness used for reference marks on the same form must be the same and be within the range from 0.3 to 1 mm. The recommended thickness is 0.5 mm.

Text (if used as reference marks)

The font size should not be less than 7 pt (headers – no less than 14 pt).

Line Separators (if used as reference marks)

Line thickness should not be less than 1 pt. The recommended thickness is 1–1.5 pt.

Barcodes (if used as reference marks)

1. The barcode width (the distance between the leftmost and the rightmost bars) should not be less than 47–50 mm.
2. The barcode height should not be less than 12–15 mm (digits not included).
3. The barcode orientation (direction of the bars) should be the same as the page orientation (it is recommended to scan the pages in the direction of the bars).
4. The EAN 13 barcode format is recommended.
5. The recommended distance between a barcode and any other form element is no less than 10 mm.

Checkmark Field

1. The recommended field sizes are 3.5x3.5 mm, 4x4 mm, 4.5x4.5 mm, or 5x5 mm (if circular checkmark fields are used, they must fit into squares of recommended sizes).
2. The recommended line width for checkmark field borders is 0.4 mm (irrespective of the size of the field).

Text Marking

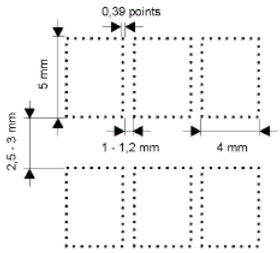
Raster dot size:

1. If the field borders are raster dots, the thickness of the raster line (i.e. the raster size) must be 0.39 pt.
2. The optimal distance between the raster dots is five times their size.

⚠ **Important!** The dots most likely to be glued together are dots in the corners of character cells.

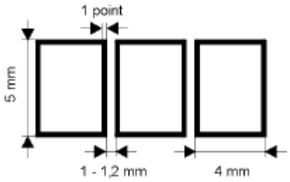
💡 **Tip**. If your software does not allow you to specify the distance between each raster dot, you must choose a line style which has dots located at sufficient distance from each other to prevent them from becoming glued together on the scanned image, and from remaining on the image after image despeckling, as big dots are not interpreted by the OCR system as garbage and are not removed from the image during despeckling.

Character cell size:



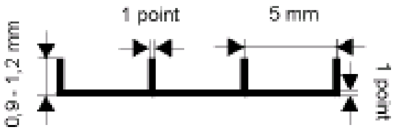
1. The recommended size of character cells is 4x5 mm; the use of smaller sizes requires a greater degree of accuracy from those completing the form, and this is very difficult to achieve. Large character cells are also not advisable as this encourages the use of abnormally large letters. Ideally, the character cell size should reflect the average letter size.
2. The distance between field lines should be no less than 2.5 – 3 mm, and the distance between two adjacent character cells in the same line should be no less than 1–1.2 mm.

Line thickness:



If the borders are black lines ("text in a frame", "letters in separate frames", or "letters in frames"), the line thickness should be 1 pt.

Combs:



1. The recommended distance between the notches in a comb is 5 mm.
2. The distance between between the horizontal lines of two combs, when positioned one below the other, should be no less than 7.5 – 8 mm.
3. The notch height must be around 0.9 – 1.2 mm.
4. The thickness of both the notches and horizontal lines should be 1 pt.
5. If frames with a comb are used, the minimum distance between frames should be 2.5 – 3 mm.

Element Positioning

1. Be sure to provide sufficient margins on your form. Otherwise, form elements which are located too close to the sides of the form may disappear during scanning, which will result in a loss of data.
2. The space between neighboring form elements should not be less than 2 mm.
3. The space between a checkmark field and explanatory text should not be less than 2/3 of the checkmark field size.
4. Make sure that the explanatory text does not overlap entry field borders.
5. If explanatory text is printed in black ink, make sure there is a distance of at least 1.5–2 mm between the explanatory text and the other elements. This distance is not so crucial for explanatory text printed in the same ink as the background.

Print Quality

When you print blank forms, keep in mind the following requirements:

1. The forms must be printed either professionally or using a printer. We recommend that color forms be printed professionally. If this is impossible, test the form color on a scanner before starting your print run.
2. All the copies of the form must be printed using the same source document, as the field location on each form must be identical.
3. The minimum margin size (i.e. the distance between the edge of the page and the nearest form element) should be at least 8 mm (12 mm margins are recommended).
4. The permitted linear deviation of form elements is no more than 0.15% (i.e. 0.5 mm for an A4–size page).
5. If you print your forms using a printer, do not print them with a resolution less than 600 dpi.
6. We recommend printing the forms with the help of the same printer or different printers of the same model.

💡 **Tip**. We do not recommend copying machine-readable forms with the help of copying equipment. Use of such equipment can slightly change dimensions of elements on the form or their arrangement, for example, table or entry fields borders may become thicker, or color depth may change, which might be detrimental for recognition quality.

Form Completion

Pens and ink

Forms are best completed neatly, in capital letters, using a black ball–point, gel or capillary pen (dark blue and violet are also acceptable). Soft–tip/felt–tip pens are not to be recommended as characters are likely to be very thick, causing recognition problems. Recognition is worst in the case of forms completed by pencil or using a light ink.

Letter size and style

For best recognition results, forms should be completed in block capital letters. The letters must fill out all character cells but must not overlap cell borders.

If character cells are visually marked on the forms (i.e. the following text marking types are used: letters in frames, letters in separate frames), the person filling out the form will be less likely to join the letters together.

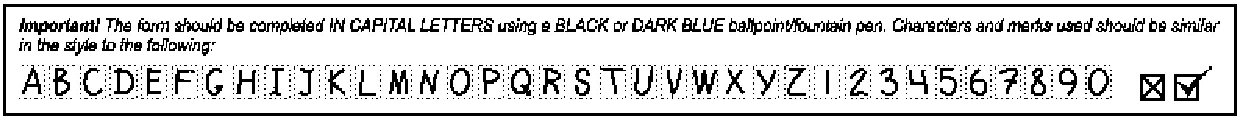
The following text marking types present greater problems for recognition: text in a frame with a comb, letters on a comb. Here only the width of the character cell is predefined, while the absence of side borders makes joining letters together possible. In the case of the comb without a frame, the letters can be written either too small or too large.

If text in a frame or text over a line are used, there is no evident restriction on the width of the character cells. The letters may be joined together, which will have an adverse effect on recognition quality. In the case of text over a line there are no restrictions on character height. Therefore this marking type is not recommended for forms requiring a high degree of recognition accuracy.

Another important requirement is that the letters do not overlap the field borders. This is not so crucial for dropout or black–and–white raster forms, because field borders will disappear during scanning and despeckling. But if letters overlap field borders on black–and–white linear forms, this may result in a significant decrease in recognition quality.

Sample

To encourage correct completion, we recommend including a note on your form similar to the one below.



Important! *The form should be completed IN CAPITAL LETTERS using a BLACK or DARK BLUE ballpoint/fountain pen. Characters and marks used should be similar in the style to the following:*

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 1 2 3 4 5 6 7 8 9 0 ☒ ☑

Recommended Colors for Dropout Forms

The table below contains dropout color samples and their corresponding Pantone numbers. These background colors disappear if forms are scanned:

- using any scanner;

Process Yellow U	100U	101U	388U	3935U	393U
102U	106U	107U	3945U	394U	3955U
108U	109U	113U	395U	3965U	396U
114U	115U	116U	461U	475U	503U
1205U	120U	1215U	586U	587U	600U
121U	1225U	122U	601U	602U	603U
123U	127U	1345U	607U	608U	609U
134U	1355U	135U	614U	691U	705U
1485U	148U	149U	706U	712U	713U
1555U	162U	169U	714U	719U	Cool Gray 1U
372U	386U	387U			

- using a color scanner with software red color filtering or using a non–color scanner with a red lamp/red filter

100U	101U	102U	1905U	190U	1915U	488U	489U	495U
106U	107U	108U	191U	1925U	192U	496U	5035U	503U
109U	113U	114U	196U	197U	198U	509U	510U	5175U
115U	116U	1205U	199U	203U	204U	517U	5245U	530U
120U	1215U	121U	205U	206U	210U	5315U	531U	585U
1225U	122U	1235U	211U	212U	213U	586U	587U	600U
123U	127U	128U	217U	218U	219U	601U	602U	603U
129U	130U	1345U	223U	224U	225U	604U	607U	608U
134U	1355U	135U	226U	230U	231U	609U	614U	656U
1365U	136U	1375U	232U	2365U	236U	663U	664U	670U
137U	141U	142U	2375U	237U	2385U	671U	672U	673U
143U	144U	1485U	238U	2395U	239U	677U	678U	679U
148U	1495U	149U	243U	244U	245U	684U	685U	691U
1505U	150U	151U	246U	250U	251U	692U	698U	699U
1555U	155U	1565U	252U	2562U	256U	700U	705U	706U
156U	1575U	157U	2572U	263U	2706U	707U	708U	709U
1585U	158U	1625U	379U	386U	3935U	712U	713U	714U
162U	1635U	163U	393U	3945U	394U	715U	719U	720U
1645U	164U	1655U	395U	459U	460U	726U	Cool Gray 1U	Orange 021U
165U	169U	170U	461U	4685U	468U	Process Yellow U	Process Magenta U	Purple U
1787U	1788U	178U	473U	474U	4755U	Red 032U	Rhodamine Red U	Rubine Red U
182U	183U	184U	475U	481U	482U	Warm Gray 1U	Warm Red U	Yellow U
185U	1895U	189U	485U	486U	487U			