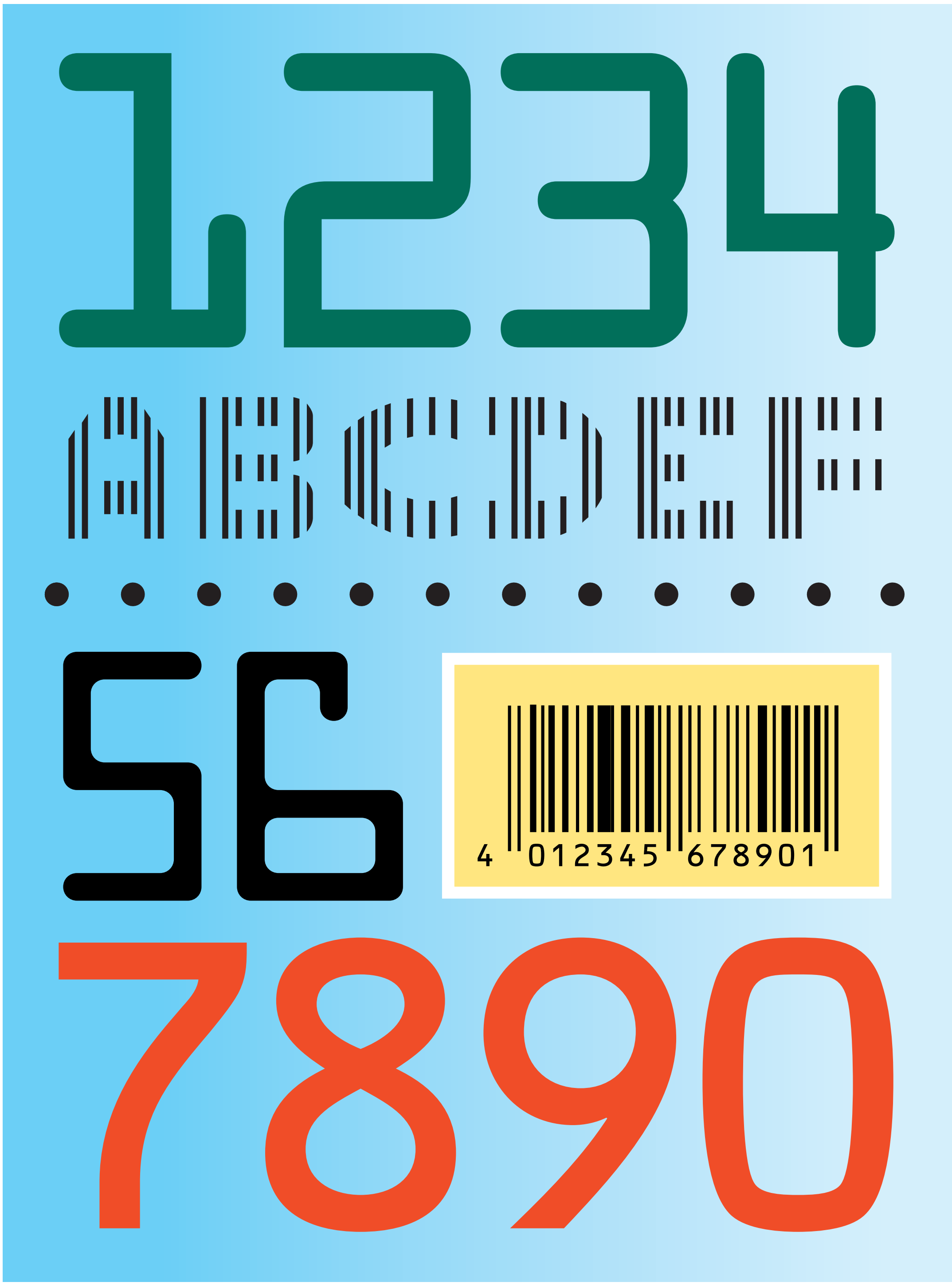
huber group

Printing inks for machine reading



Contents

Introduction

The starting point for the development of machine reading was man's desire to construct an eye for his superfast computer. It was in the 50 s that the breakthrough came: machine-reading developers in the USA succeeded for the first time in exceeding the speed at which we are able to say letters out loud. Numbers were no longer typed in, but recognized by a magnetic ink character reader (MICR) and evaluated. The font that was developed especially for this purpose is known as E 13 B.

Fig. 1
E 13 B font

Optical reading came slightly later and was first put to commercial use round 1960 at IBM. This system was indeed capable of reading only numbers and a few special characters, but it could already process 400 characters/s, and consequently set a development process rolling that helped machine reading to achieve widespread usage at the beginning of the 70 s. Today, we have optical readers that recognize all types of typewriter and printing types, even handwritten block capitals, and evaluate them. And they are also capable of processing up to 3,000 characters/s.

The expositions that follow look into the significance of printing inks in this field and provide a description not only of machine-readable printing inks, but also of those inks that carry background information for the user, without “addressing” the reading machines.

Overview of the reading techniques

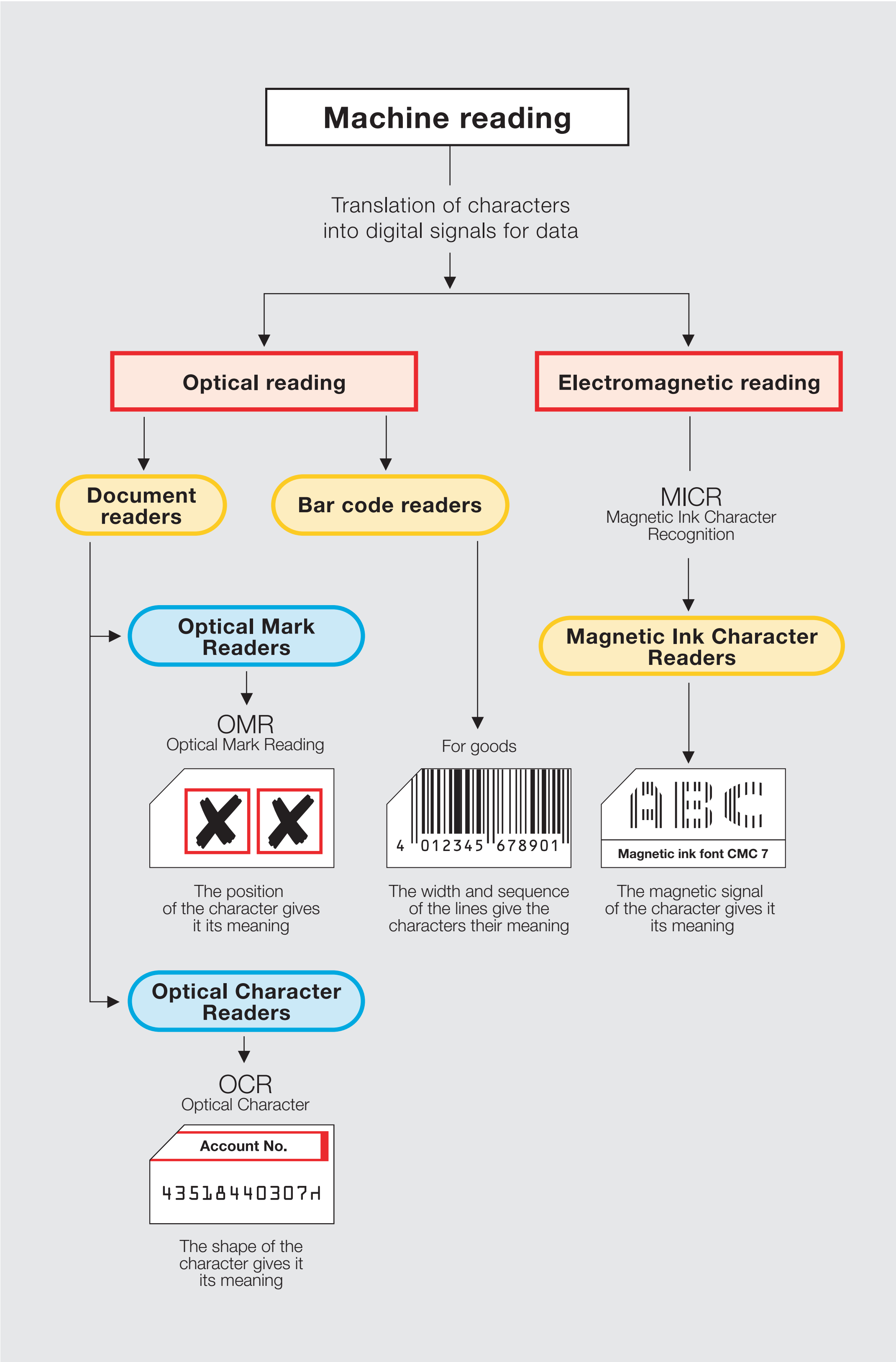


Fig. 2
Overview of the reading techniques

Optical reading

Physical fundamentals

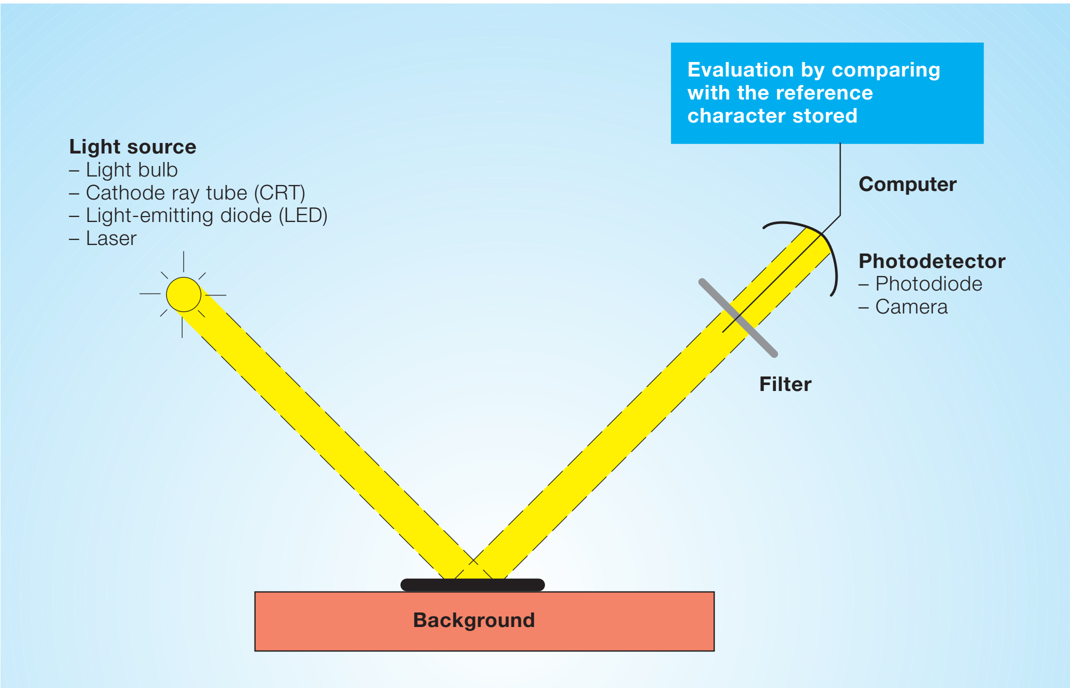
In the same way as when we read using our eyes and evaluate by means of thought processes, there are four preconditions required for optical reading, too:

- a light source
- a dark character on a light background
- a sensor, and finally
- an evaluation system.

Fig. 3 below depicts the functional principle at work.

This illustration clearly shows how it is the interaction between the light source, object and receiver that enables a result to be achieved at all. Each of these three components has a crucial role to play. Interfering (wavelength) bands can be suppressed by filters located in front of the receiver. Fig. 7 provides information on the significance of such filters. Evaluation is performed by a computer that compares the signals received with the ideal image of the reference character stored. The receivers can be set such that they are sensitive to different bands. For example, some receivers make use of the reflectance of the character in the infrared radiation band.

Whatever the case, character recognition is based on the contrast between the characters and the background. This contrast, of course, depends on the type of illumination and can therefore be different under the green light of a CRT compared with under infrared radiation.



The character is illuminated and projected onto the photodetector.

Sensing options for character recognition:
Scanner – The characer is sensed (read) dot-by-dot and screened in the same way.
Camera – The character is projected onto a photocell matrix and screened in gray levels.

Fig. 3
Contrast-dependent character recognition

Document readers for character and type recognition

This designation has come to be the generic term covering all readers that can read or evaluate marks or types. The term “document” is used here to refer to such data media as checks, forms, entrance tickets and questionnaires.

Optical Mark Readers – OMR

(Optical Mark Reading)

Machine reading and evaluation of documents whose informational content consists in the main of pencil marks at preprogrammed positions basically only requires machines that register the correct position of the character and do not actually “read” it. Applications include questionnaires, ballot papers and Lotto coupons. Documents of this kind can be evaluated at a speed of 6 – 7,000 pieces/h.

Depending on the optical reading system, i.e. on the light source, filter and spectral sensitivity of the photodetector, the background of the document can be printed with colored inks without disturbing the contrast-dependent recognition of the character. Unfortunately, the indication “for mark readers” still does not provide any guarantee as to the permissible color tones for the background; you still have to know what type of optical reading system is being used.

When using optical mark readers equipped with an infrared reading head, it is possible to use non-read colors from every range of color tone, since almost all colored pigments reflect infrared radiation just as well as blank paper does. In this case, the marks must be made using a pencil or black ballpoint pen. If a red-light reading head is being used for processing, any conventional writing implement, such as a blue ballpointpen (with the exception of a red pen), can be used for making the marks. The background shades then have to be restricted to yellow, orange and red, since only these chromatic colors reflect red light.

This context is best understood if you carry out the following experiment:

Look at one blue, one red and one yellow printed image through a red filter. The blue image will appear black through the red spectacles, whereas the red and yellow images cannot be distinguished from blank paper.

Different color rules must be observed for each type of device. The correct coordination of background colors to the different types of reader can be found on our color card entitled “Overview of background colors and readers”.

When processing background inks in the printing house, you should avoid mixing different printing inks and any form of contamination, particularly through inks that contain soot. The optical reading system reacts to this even more sensitively than the human eye. The cause of this can be found in the high absorbing capacity of soot or graphite for every type of light used for measurement purposes, also for infrared light.

Optical character readers – OCR

(Optical Character Recognition)

Optical character recognition is used for “reading” numbers and types. The reading capacity of modern machines is no longer restricted to printing types or typescripts, but also covers handwritten numbers and block capitals. The OCR-A and OCR-B types, that were developed round 1970 for optical reading, are still in use today despite there being more than 100 other different machine-readable types. Since a handwritten character can only be analyzed by an optical character reader if it is separate from its neighbors, the background colors of forms have the task of indicating the reading zones and separating them from one another. The terms “non-read color” and “drop-out ink” highlight the fact that they must not be recognizable to the optical reading system

ABCDEFGHIJKLMNOPQRSTUVWXZ
abcdefghijklmnopqrstuvwxyz
1234567890

Fig. 4
OCR-A type

ABCDEFGHIJKLMNOPQRSTUVWXZ
abcdefghijklmnopqrstuvwxyz
1234567890

Fig. 5
OCR-B type

during the sensing, i.e. reading process. If we compare these background colors with those used with optical mark readers, we discover that they are a lot lighter. The high sensitivity of the optical reading system, which, for example, enables it to identify blue characters, does not permit the use of stronger background colors and, moreover, makes high demands on their purity. The reader is able to recognize dirt in the ink even though it is still invisible to the human eye.

Each optical reading system requires the use of special background colors. Some readers are able to use different optical possibilities depending on the color of the readable characters.

The informational publications provided by the machine manufacturers will tell you more about this. Moreover, the coordination of background colors to the different types of reader can be found on our color card entitled “Overview of background colors and readers”.

Categorization of optical character readers acc. to their reading rate

The following designations have also been introduced together with the term “font” that refers to a particular set of characters available:

- single-font reader
- multi-font reader
- omni-font reader.

In addition to these, there are also company-specific names such as Polyfont and Allfont on the market.

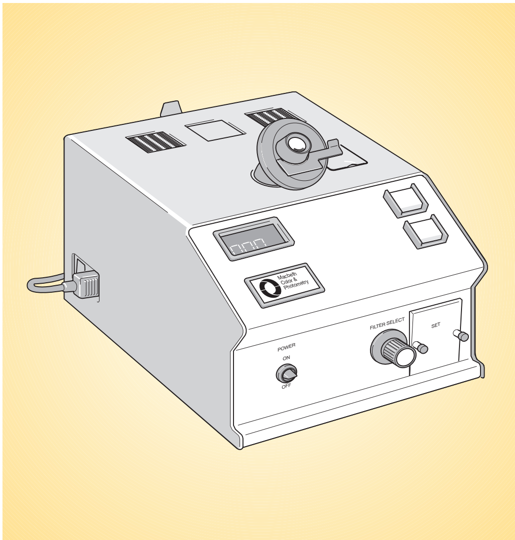


Fig. 6
Print Contrast Meter PCM II

Suitability test of the background inks

Through cooperation between machine and ink manufacturers, it has been possible to define color standards that are presented on color charts or in color gamuts. However, print-ing houses have to do more than just order the right printing ink; they also have to continuously take measurements during the print run in order to monitor the optical characteristics of the printed images. Macbeth offers its Print Contrast Meter PCM II* as a test device that “simulates” the various readers available. This meter is equipped with a selection of filters from which you can choose.

The various manufacturers of readers refer to this test device in their informational publications and specify the selection of a particular filter for use when performing measurements on their readers. Once it has been set to the calibration standard, the PCM II measures not only the reflectance value for the blank paper, but also that for the print. These values are then used to calculate the contrast between the print and the blank paper to give the PCS (Print Contrast Signal). The formula used is as follows:

$$\textbf{PCS} = \frac{\textbf{paper reflectance – ink reflectance}}{\textbf{paper reflectance}}$$

Generally speaking, this value must not exceed 0.10 for background inks.

Example: RW = 100% (Reflectance of the white standard Ba sulfate. The calibration standard is not 100%.)
RP = 90% (Reflectance of the blank paper)
RD = 83% (Reflectance of the printed image)

$$\text{PCS} = \frac{90 - 83}{90} = \frac{7}{90} = 0.08$$

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The PCS value is from time to time specified as a percentage; instead of 0.08, we then talk of 8%.

The higher the reflectance of the background ink, the smaller the contrast.

This connection can also be graphically presented in the form of the reflectance curves for the paper and the background ink: only that section of the spectrum is used for evaluation purposes, that can actually pass through the filter (Fig. 7).

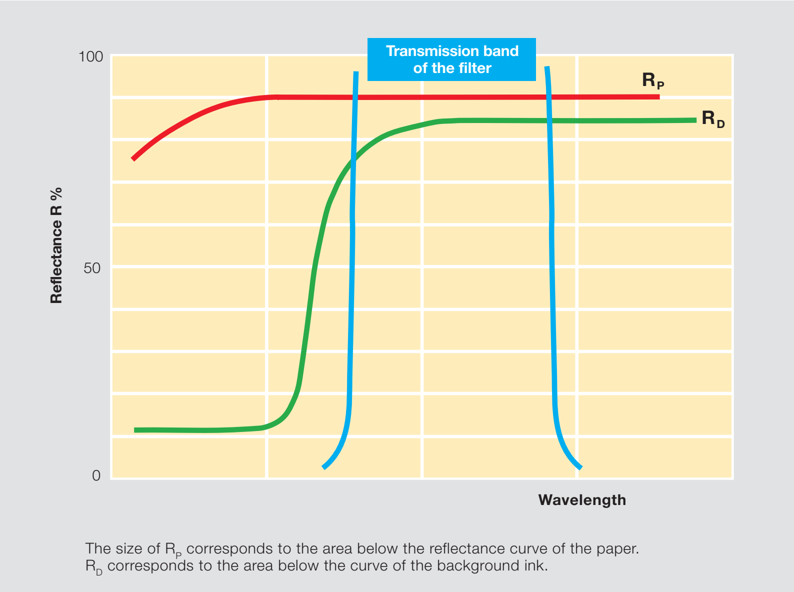


Fig. 7
Reflectance of paper and background ink

The sensitivity of the photodetector is indeed within the transmission band of the filter, but it is not the same for all wavelengths and still has to be included in the calculation of the reflectance curves in order to measure the contrast. For the sake of simplicity, this adjustment has not been shown in Fig. 7.

The ink manufacturer can check the reflectance curves by plotting them with the aid of a spectro-photometer. It is, therefore, possible to spectrophotometrically check proofs of background inks during their quality inspection to ensure that they conform with the color standard that has been laid down together with the manufacturer of the reader.

This possibility does not do away with the need to check the documents at the print house, since the PCS value can also be influenced by the inking, printing stock, reverse-side printing and by the level of cleanliness during the printing process.

Suitability test of the printing inks for the readable type
Readability is likewise assessed by means of the PCS value. Black printing inks normally contain soot as their black pigment and therefore absorb not only visible light, but even infrared radiation. Generally speaking, a character is regarded as being readable if the PCS value is at least 0.4.

Here, too, print houses still have to carry out additional checks. The type and layout of the characters have to be determined in accordance with DIN 66 008 for Type A and DIN 66 009 for Type B. Furthermore, DIN 66 223 has to be taken into consideration, which deals with the optical characteristics of the character substrate (i.e. the paper) and with the print quality, the contours and the PCS values of the printed characters.

Bar code readers for goods identification

The above description of optical character readers shows us just how complex the technology for machine-reading numbers actually is. In contrast, it is relatively simple to read a number that is in the form of a sequence of bars by optoelectronic means and to pass it on to the data-processing system. This is why article numbers used to identify goods are depicted as a combination of bars in the European Article Number (EAN) and American Universal Product Code (UPC) systems.

In addition, bar codes have also been developed for numerous other applications. The most common codes are:

137
2/5 3bars

TELEPEN CODE

3 012345 678902
UPC/EAN

PLESSEY CODE

DALOG
α 39

375780
2/5 INDUSTRIAL

CODE 93

CODE 128

137
2/5 DATALOGIC

0140
CODABAR

01
Δ IBM

Code 39 is an alphanumeric bar code which is mainly used in the pharmaceutical industry.

Fig. 8
Bar codes

EAN-Code

The optical reading system uses an HeNe laser as its light source. This laser emits red light with a wavelength of 633 nm. During scanning, the light/dark sequence is picked up by a photodiode and converted to an electrical pulse group. When printing this code, specifications have to be complied with that are described in DIN 66 236.

The following applies for the contrast between the characters and the background:

$$K = \frac{\text{reflectance of background} - \text{reflectance of character}}{\text{reflectance of background}}$$

The required minimum contrast depends on the reflectance of the background. The EAN code is usually printed black on white, but the required contrast can also be achieved through a combination of chromatic colors for characters and background if the reflectance values at 633 nm are far enough apart. The optical reading system, therefore, does not “see” the colors in the same way as the human eye; rather it evaluates the contrast only at this one wavelength. Similar to the case with document reader inks, it is not possible to judge whether they are readable or not by simply looking at them.

These reflectance values are known for the inks that belong to the PANTONE® gamut and listed on the following pages. This list can be used to choose from a large number of suitable color combinations for the EAN code, so long as you make use of the chart below which uses a characteristic curve to separate the suitable combinations from the unsuitable ones. (Fig. 9 – Chart for finding suitable color combinations for EAN code) In practice, a check must be conducted on print run paper using a code reader before an actual print run is printed.

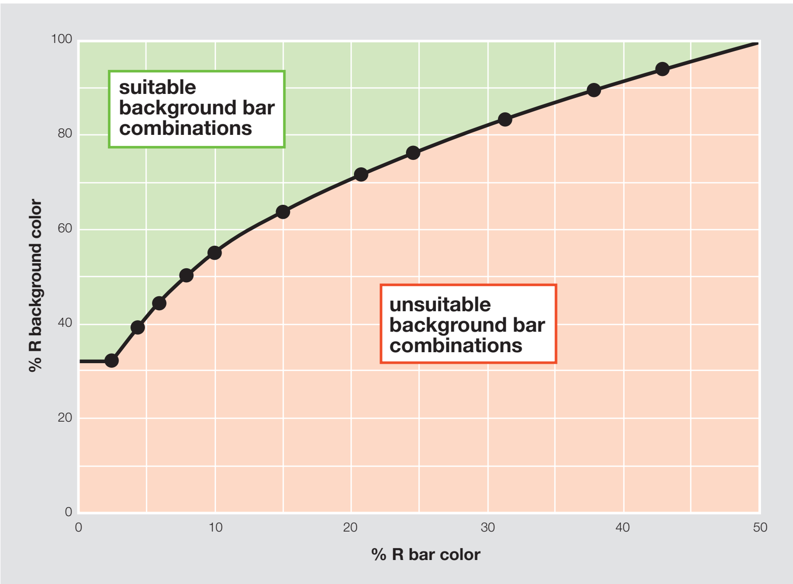


Fig. 9
Characteristic curve for evaluating color combinations for EAN code

The following example should make it clear how to use the chart in Fig. 9:

A light blue background such as PANTONE® 277 is wanted for the new color design of a piece of packaging. The color of the bar should be dark blue. On looking through the list of background colors, you find the reflectance value 55.5% for PANTONE® 277. From the chart, you can now see that with this level of background reflectance, only those bar colors whose reflectance value does not exceed 11% come into question. You then turn to the list of bar colors and check the dark blue you want to use to see whether or not it is suitable.

Background colors

Reflectance values R in % at 633 nm of PANTONE® colors

PANTONE®	% R	PANTONE®	% R	PANTONE®	% R	PANTONE®	% R
Yellow	87.3	1355	87.4	177	88.1	225	85.1
Warm Red	84.5	1365	87.0	178	87.0	226	81.6
Rubine Red	81.4	1375	86.7	179	65.6	227	47.9
Rhodamine Red	79.8	1385	50.5	180	44.0	230	87.9
Purple	74.6	141	87.7	1765	87.5	231	87.0
Yellow 012	87.3	142	87.9	1775	87.8	232	85.8
Orange 021	86.3	143	87.5	1785	86.6	233	62.3
Red 032	85.1	144	86.9	1788	85.1	234	38.1
Process Yellow	87.0	145	61.0	1795	64.2	236	87.4
Process Magenta	83.2	146	34.7	1805	41.9	237	86.3
100	87.7	148	87.9	182	87.9	238	84.5
101	87.9	149	88.4	183	87.7	239	81.5
102	87.6	150	87.7	184	86.9	240	55.6
103	52.6	151	87.1	185	84.4	241	42.6
104	39.6	152	63.1	186	64.0	243	87.2
106	87.9	153	39.9	187	40.3	244	87.2
107	87.9	155	88.1	189	87.7	245	85.8
108	87.6	156	88.5	190	87.4	246	78.2
109	87.7	157	87.8	191	86.5	247	60.9
110	62.0	158	86.9	192	84.2	248	42.3
111	37.4	159	64.6	193	52.4	250	87.2
113	88.0	160	38.6	194*	31.6	251	86.1
114	88.1	1555	87.8	196	87.4	252	81.9
115	88.1	1565	88.0	197	87.5	253	64.3
116	87.6	1575	87.2	198	86.1	254	44.6
117	50.6	1585	86.7	199	83.8	256	73.3
118	38.4	1595	54.6	200	62.1	257	64.0
120	88.2	1605*	33.5	201	40.6	258	53.5
121	87.9	162	88.2	203	87.6	2563	56.4
122	87.9	163	88.1	204	87.2	2573	41.7
123	87.8	164	87.6	205	85.9	2567	46.6
124	63.6	165	86.6	206	82.7	2577*	33.3
125	39.5	166	63.5	207	51.6	263	76.6
127	88.1	167	41.1	210	87.7	264	59.0
128	88.1	1625	87.4	211	87.3	265*	32.5
129	87.8	1635	87.5	212	85.7	2635	50.9
130	87.3	1645	87.0	213	85.1	2645	39.9
131	61.8	1655	85.9	214	61.0	270	53.8
132	37.2	1665	64.4	215	36.4	271	38.1
134	88.1	1675*	31.9	217	87.9	2705	36.7
135	88.1	169	88.2	218	87.4	277	55.5
136	87.7	170	88.1	219	85.8	278	37.7
137	87.4	171	87.3	220	53.5	283	44.2
138	62.1	172	86.3	221	37.5	290	54.4
139	33.6	173	55.2	223	87.3	291	38.6
1345	87.0	176	88.2	224	86.8	297*	32.6

PANTONE®	% R	PANTONE®	% R	PANTONE®	% R	PANTONE®	% R
2975	41.8	428	55.0	481	73.3	5455	67.4
304	49.9	429	40.2	482	80.4	550*	31.6
317	56.6	434	59.1	484	41.9	551	46.0
318	35.3	435	48.0	485	84.7	552	59.1
324	46.3	436	35.2	486	88.1	5503	39.3
3245*	31.6	441	48.4	487	88.7	5513	58.7
3248	32.9	442	38.2	488	88.6	5523	70.5
331	49.5	Warm Grey 1	77.6	489	88.6	5507	42.2
337	44.0	Warm Grey 2	66.6	493	54.9	5517	56.6
344	48.1	Warm Grey 3	54.1	494	71.1	5527	66.7
345	35.2	Warm Grey 4	50.7	495	76.3	557	43.6
351	44.2	Warm Grey 5	44.8	496	80.9	558	55.7
352*	33.7	Warm Grey 6	41.1	500	41.1	559	63.4
358	41.7	Warm Grey 7	35.4	501	61.5	5575	40.5
359	37.5	Cool Grey 1	77.3	502	72.6	5585	49.6
365	63.8	Cool Grey 2	68.7	503	76.2	5595	62.7
366	53.8	Cool Grey 3	61.5	5005	44.1	564*	31.1
367	40.5	Cool Grey 4	56.4	5015	57.9	565	45.1
372	66.7	Cool Grey 5	49.0	5025	65.8	566	55.6
373	57.0	Cool Grey 6	41.9	5035	74.8	5635	34.6
374	43.2	Cool Grey 7*	33.9	507	50.0	5645	50.1
379	74.4	451	41.8	508	64.5	5655	58.8
380	68.7	452	55.8	509	72.0	5665	67.3
381	61.0	453	63.1	510	76.3	571	34.7
382	49.4	454	69.5	514	52.6	572	49.0
383	37.6	4505	34.7	515	62.7	573	58.5
386	76.3	4515	47.3	516	73.4	577	48.5
387	70.8	4525	57.9	517	77.5	578	55.9
388	63.6	4535	69.8	5145	44.9	579	64.0
389	56.7	4545	74.8	5155	60.2	580	70.3
390	44.0	457	39.9	5165	70.4	5773*	32.8
391*	32.9	458	68.4	5175	76.9	5783	45.0
393	84.5	459	74.9	521	43.0	5793	55.6
394	80.0	460	79.6	522	53.2	5803	65.7
395	75.6	461	81.8	523	65.4	5777	38.4
396	66.0	465	55.9	524	71.2	5787	56.2
397	48.3	466	65.8	5215	34.7	5797	64.9
398	39.3	467	71.4	5225	45.6	5807	70.8
3935	85.8	468	78.2	5235	61.6	583	40.0
3945	83.5	4645	38.4	5245	71.7	584	67.0
3955	80.0	4655	53.0	528	44.7	585	71.5
3965	73.0	4665	63.5	529	61.2	586	76.3
3975	41.7	4675	73.0	530	68.4	587	79.9
400	62.0	4685	79.2	531	77.1	5835*	32.9
401	52.8	471	39.4	5295	39.9	5845	42.1
402	40.3	472	66.9	5305	52.2	5855	56.0
406	59.0	473	75.9	5315	67.6	5865	64.9
407	46.2	474	80.8	535	34.8	5875	73.4
408	37.9	475	83.6	536	43.1		
413	56.6	4715	36.2	537	54.6		
414	45.6	4725	50.7	538	68.1		
415	36.6	4735	61.4	543*	32.8		
420	64.3	4745	68.3	544	46.8		
421	52.0	4755	78.2	545	56.3		
422	42.4	479	47.7	5435	42.6		
427	67.9	480	65.2	5445	55.5		

*critical

Bar colors

Reflectance values R in % at 633 nm of PANTONE® colors

PANTONE®	% R	PANTONE®	% R	PANTONE®	% R	PANTONE®	% R
Violett	7.0	2623	9.9	2985	16.2	3285	2.5
Reflex Blue	0.87	2587	20.0	2995	6.3	3295	1.9
Process Blue	1.24	2597	9.1	3005	1.95	3305	2.0
Green	0.82	2607	7.3	3015	1.3	3258	24.0
Blue 072	0.84	2617	6.9	3025	1.3	3268	3.0
Process Cyan	5.45	2627	5.5	3035	1.6	3278	2.5
Process Black	2.10	266	14.1	305	25.8	3288	3.0
105	20.7	267	10.4	306	12.3	3298	2.4
112*	28.7	268	8.5	307	0.9	3308	2.0
119	20.0	269	7.3	308	0.8	332*	30.7
126*	29.8	2655	25.9	309	1.6	333	16.5
133	17.9	2665	16.0	310*	28.5	334	0.7
140	15.6	2685	4.5	311	16.1	335	1.1
1395	24.8	2695	4.2	312	5.1	336	1.2
1405	10.8	272	24.2	313	0.98	338*	28.9
147	12.2	273	4.6	314	0.8	339	9.6
154	25.6	274	3.5	315	0.9	340	2.7
161	13.6	275	3.2	316	1.8	341	2.5
1615	19.5	276	3.5	3105	27.1	342	2.7
168	14.5	2715	22.0	3115	13.2	343	3.2
1685	19.0	2725	11.4	3125	6.8	3375*	30.6
174	25.1	2735	3.1	3135	1.8	3385	18.6
175	11.2	2745	2.5	3145	1.8	3395	6.7
181	17.2	2755	2.4	3155	1.1	3405	1.7
1815	20.6	2765	2.3	3165	0.9	3415	1.4
188	19.2	279	15.3	319	17.0	3425	1.4
195	15.8	280	1.2	320	1.31	3435	1.5
202*	28.8	281	1.0	321	1.1	346	24.0
208*	29.5	282	1.3	322	1.2	347	3.0
209	18.9	284	27.3	323	1.7	348	2.5
216	18.9	285	6.5	325	20.6	349	3.7
222	18.7	286	1.2	326	6.1	350	4.3
228	27.9	287	0.8	327	1.2	353	27.1
229	14.3	288	0.8	328	1.2	354	1.6
235	25.1	289	1.4	329	1.2	355	1.7
242	19.5	292	20.2	330	2.7	356	1.5
249	22.6	293	1.8	3242*	29.0	357	3.4
255	24.3	294	1.3	3252	15.5	360	21.5
259	18.0	295	1.4	3262	6.2	361	11.1
260	13.5	296	1.9	3272	1.8	362	10.1
261	11.4	298	16.6	3282	1.6	363	11.1
262	10.1	299	6.9	3292	1.2	364	8.1
2583*	29.4	300	0.9	3302	1.4	368	19.1
2593	17.0	301	0.7	3255	17.3	369	15.2
2603	12.0	302	1.3	3265	5.7	370	11.8
2613	10.5	303	1.7	3275	2.2	371	10.1

PANTONE®	% R
375	22.1
376	18.3
377	13.8
378	8.1
384	29.7
385	19.1
392	23.6
399*	30.6
3985	27.7
3995	15.3
403*	28.7
404	19.4
405	12.2
Black	4.5
409*	28.8
410	20.3
411	12.3
412	4.2
416	24.6
417	16.1
418	11.4
419	4.0
423*	29.5
424	19.6
425	10.6
426	3.3
430	27.7
431	14.7
432	8.0
433	3.5
437	14.5
438	3.7
439	2.7
440	3.0
443	26.2
444	15.2
445	4.2
446	3.1
447	3.5
Warm Grey 8*	30.1
Warm Grey 9	24.7
Warm Grey 10	20.9
Warm Grey 11	14.4
Cool Grey 8*	28.7
Cool Grey 9	25.3
Cool Grey 10	17.8
Cool Grey 11	13.7
448	7.9
449	11.9
450	13.8
4485	10.1
4495	23.5
455	13.0
456	29.1
462	11.5
463	21.1

PANTONE®	% R
464	29.2
4625	8.3
4635	22.4
469	11.4
470	24.2
4695	9.4
4705	23.0
476	12.0
477	14.3
478	18.9
483	18.1
490	9.4
491	15.9
492	22.5
497	5.0
498	8.0
499	9.7
4975	5.6
4985	16.3
4995*	30.2
504	7.2
505	13.2
506	17.0
511	9.4
512	15.0
513	20.2
5115	7.6
5125	16.5
5135*	29.4
518	7.5
519	10.5
520	11.3
5185	3.4
5195	6.8
5205	19.0
525	10.5
526	14.1
527	19.1
5255	2.6
5265	4.7
5275	11.1
5285	23.9
532	4.5
533	4.0
534	4.8
539	1.8
540	1.5
541	1.9
542	18.3
5395	2.1
5405	6.6
5415	12.5
5425	25.5
546	1.6
547	1.5
548	1.8

PANTONE®	% R
549	21.4
5463	1.5
5473	5.2
5483	14.9
5493	27.1
5467	2.4
5477	7.4
5487	16.5
5497*	29.1
553	4.1
554	6.2
555	6.5
556*	30.8
5535	1.8
5545	6.3
5555	15.4
5565	24.9
560	2.3
561	2.5
562	2.9
563	18.6
5605	2.7
5615	10.8
5625	19.6
567	3.0
568	2.1
569	2.4
570	21.5
574	9.5
575	13.0
576	18.4
5743	4.5
5753	11.8
5763	18.7
5747	3.9
5757	13.5
5767	24.3
581	12.8
582	25.8
5815	5.8
5825	17.3
877	24.4

PANTONE®	% R

*critical

Color code for controlling packaging processes
It has always been particularly difficult to quickly detect contamination or variations during the production process in the pharmaceuticals industry. Packaging and identification processes conducted on small objects demand considerably more than the human eye can offer at high speeds. We can no longer imagine such processes without the use of optoelectronics. Monitoring based on the principle of the camera enables an object to be imaged onto a photosensitive layer, the silicon target, that is made up of a large number of silicon diodes (up to 200,000). The sensitivity of the target covers a range from ultraviolet through the visible spectrum up to infrared. The projected image is in this way screened into its gray shade levels and compared by the microprocessor connected downstream with the ideal image stored for the object. Deviations in the external shape, e.g. in the size of the tablet, are detected just as well as the difference from preprogrammed color ring combinations. No color measurement is taken, merely an evaluation of the gray levels of the colors read in. Colors that can be recognized must lie above a minimum gray shade, so that the operating threshold is exceeded. The informational publications provided by the manufacturers of color-code readers will give you all the necessary details about the permissible color combinations.

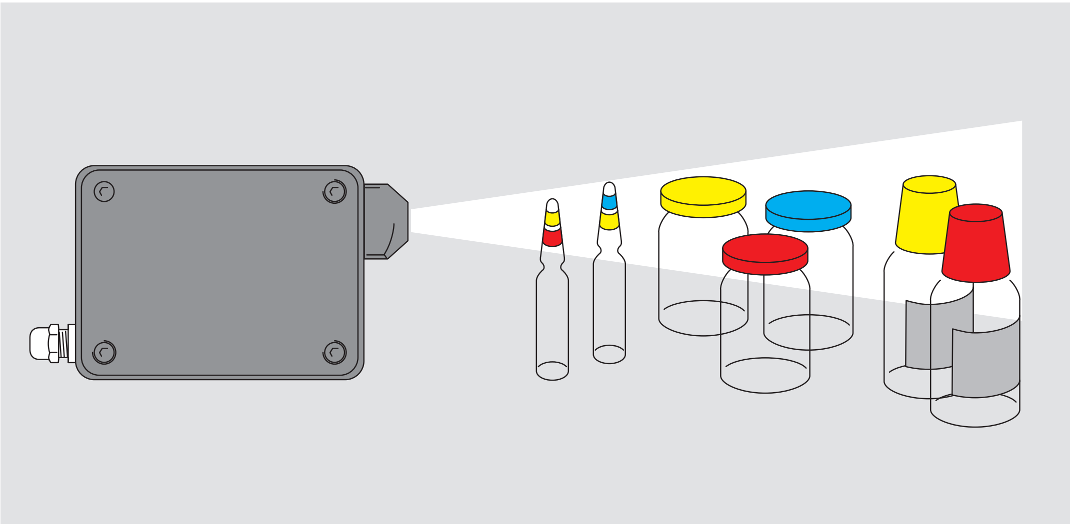
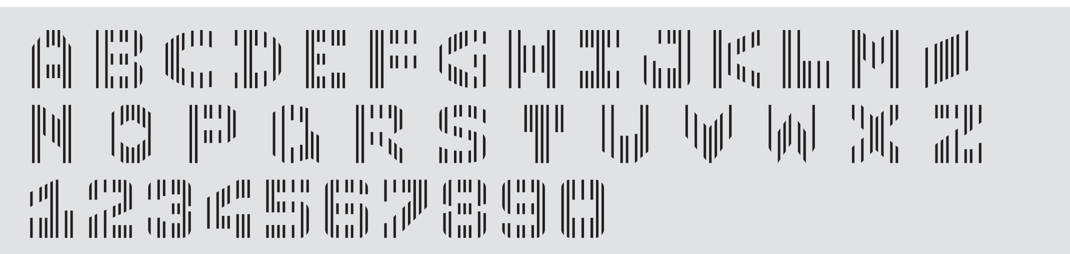


Fig. 10
Color code reader

Electromagnetic reading – MICR
(Magnetic Ink Character Recognition)

The first magnetic ink character readers were developed in the USA in the 1950s for reading bank documents. As already mentioned, the E 13 B font was used. In 1964, the Deutsche Bundespost first put the CMC 7 font to use, that had been developed in France. The application principle is comparable with that of a sound recording tape. The main difference is that the layer is printed on with MICR. The printing ink contains magnetizable ferric oxide of type Fe_3O_4.
Quite simply, it is the sequence of vertical bars and spaces that is used for magnetic recognition. In order to make the characters visually readable, too, the bars have been shortened to the now familiar contours.

Fig. 11
Magnetic ink font CMC 7 (Caractère Magnétique Code à 7 bâtonnets, bâtonnets = little sticks)



In printed form, this font is initially only visually readable; it only takes on its magnetic informational content if it is passed through a strong magnetic field, i.e. magnetized, before it is forwarded for machine evaluation. Crucial in this regard is the characteristic of the magnetic pigment by which it remains magnetic after leaving the magnetic field. This retained magnetic characteristic is known as “remanence” (from the Latin remanere = remain).

The concentration of ferric oxide in the printing ink and the layer thickness of the printed character determine the intensity of the “playback signal” that is finally picked up by a “sound head”.

For printing houses, therefore, the principle that has to be adhered to here too is: it is not enough just to use the right printing ink; you also have to continuously take measurements during the print run in order to monitor the magnetic characteristics of the printed images.

A suitable test device is manufactured by Atlantic Zeiser GmbH, D-78576 Emmingen, under the name CODATEST.

To guarantee reading reliability, the dimensions of the printed characters and the quality of their contours must satisfy the high requirements laid down in the standard ISO 1004. Two excepts from this 50-page standard illustrate the requirements set by this standard with respect to precision.

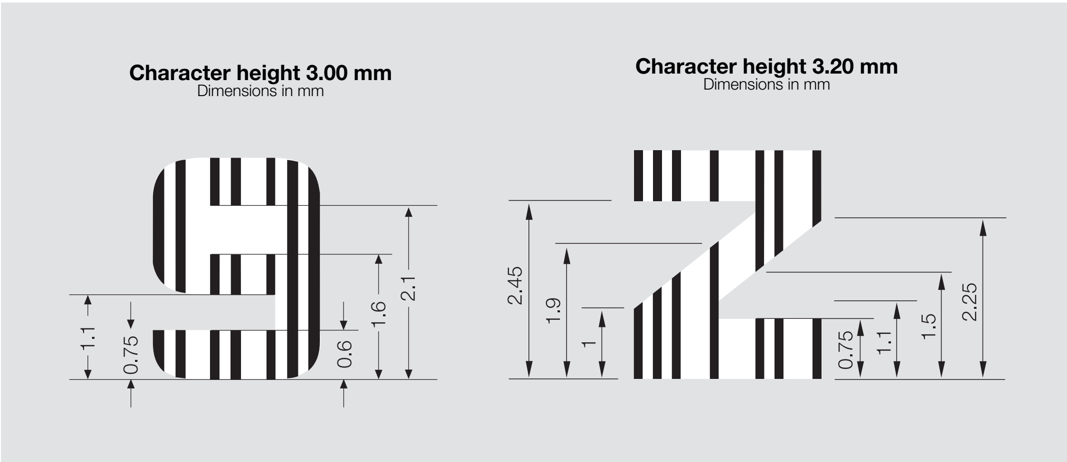


Fig. 12
Dimensional specifications of magnetic ink font CMC 7

One advantage of MICR is its low level of susceptibility to interference caused by foreign inks in the reading zones, since they do not react to magnetic fields. The print house, however, still has to ensure that the magnetic ink fonts are stored in the character set of the optical reader, so that they can be read optically if the reading zones are clean.

Magnetizable ferric oxides are black or brown and can therefore not be used for mixing light or colored printing inks.

They are not, however, restricted just to being used for fonts (i.e. letters and numbers); they can also be used for printing register lines or orientation bars on documents, that can even be magnetized and “read” through an envelope.

Summary

The various application techniques used in the field of machine reading are subject to rapid further development through innovations in equipment.

For this reason, this information bulletin can only reflect the state of the art at the time of publication. Different color rules must be observed for each type of device. The correct coordination of back-ground colors to the different types of reader can be found on our color card entitled “Overview of background colors and readers”.