INTERNATIONAL STANDARD

ISO 12642

First edition
1996-12-15

Graphic technology — Prepress digital data exchange — Input data for characterization of 4-colour process printing

Technologie graphique — Échange de données numériques de préimpression — Données d'entrée pour caractérisation d'impression en quadrichromie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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International Standard ISO 12642 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

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Annexes A and B of this International Standard are for information only.

Introduction

General background

The technical content of this International Standard is identical to the American National Standard IT8.7/3-1993. The ANSI document resulted from the joint efforts of an international industry group that included participants representing a broad range of prepress vendors, film manufacturers, and users. This group, initially identified as the DDES (Digital Data Exchange Standards) Committee, later became the founders of the ANSI IT8 (Image Technology) accredited standards committee which is responsible for electronic data exchange standards in graphic arts prepress.

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In an environment in which colour information is passed between electronic publishing systems, it is essential for colour to be defined in an unambiguous manner. Substantial experimental evidence enables us to conclude that, for foveal vision, this can be achieved by specifying the mixture of three linearly independent stimuli required to match that colour. In 1931 a complete system of colour definition was developed by the CIE (Commission Internationale de l'Eclairage) based on experimental evidence published in the previous decade. This evidence confirmed the similarity between observers in making such a match. That system and its derivatives are now universally accepted for colour specification.

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Many half-tone colour printing processes, however, require more than three colourants. There are two reasons for this. Generally the gamut of colours achievable with three printing inks is rather limited, and printing additional inks can extend the gamut significantly. Furthermore, the provision of extra inks can reduce the magnitude of the visual change caused by the variability in colour and register which arises in print production. By far the most common additional ink used is black, and four-colour process printing is accepted as the norm for most forms of printing.

The addition of an extra ink means that the production of a colour cannot, in general, be defined uniquely. As a result, different parts of a printed sheet may use varying ink combinations to achieve the same colour. For many practical purposes it is desirable to specify this combination directly, rather than encode it by rules, and this leads to the requirement to transfer data in a four-colour, device-specific mode. If the same data is to be used for other applications, or even if it needs to be modified for a different set of printing characteristics, some additional information is necessary to enable the receiver of the data to interpret it. This International Standard has been developed to achieve this objective. It provides a data set which can be transmitted with an image to enable the receiver, if required, either to transform the data into a device-independent state or correct it for a different printing characteristic. An alternative application of the tools provided by this International Standard is to enable the characterization of output systems and in this context work has been undertaken by the committee to generate data for the major types of half-tone printing processes which have been specified internationally. This procedure is described in the application notes (annex A) and the data will be published in future annexes.

The body of this International Standard defines the ink values to be used for characterizing any four-colour (cyan, magenta, yellow, and black) half-tone printing process (including gravure). These ink values are defined as either digital data in a computer or half-tone tone values on film. This requires that particular care be taken in the preparation of film to ensure that the output device is properly "linearized" and the half-tone film values match the numerical data in the computer file. For some applications the film values used for linearization may be one or more generations removed from the film produced by the film writer. The measurement procedures and the data format to be used in determining and reporting tristimulus values (X,Y,Z) are also included.

While the technique employed in this International Standard applies to all output processes, the data has been optimized for four-colour half-tone printing. For non-half-tone processes, or those which use colourants that are significantly different from typical printing inks, the reference data file should be determined in such a way that it provides reasonably uniform colour differences when the data file is rendered. For a system which does not meet the criterion, the user-optional data set could be utilized. Suggestions for this are made in the application notes; however, they are not part of this International Standard.

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It should be noted that this International Standard does not define the physical layout of the patches or their size. This is because any such decision depends on the printing device to be used, and the area required for colour measurement. It is anticipated that a specific layout will be produced to suit the needs of the user. However, in order to realize the colours necessary for the measurements of specific printing processes to be included as future annexes, it was necessary to produce a specific layout. This layout, composed of four groups of patches, has been adopted by both ANSI/CGATS and ISO/TC 130. Within TC 130 the digital data in the appropriate format is contained in images S7 through S10 of the Standard Colour Image Data (SCID), ISO 12640. For the guidance of others, this layout is shown in figure A.1.

Technical background

Printing characteristics

Various efforts have been made over the past 20 years to reduce the variation which occurs between printing presses. Initially, standards such as ISO 2846 were developed to specify the colour of printing inks. Subsequently, as a result of the lead of FOGRA/BVD in Germany, significant effort has been made in developing specifications which define constraints for the ink transfer onto paper. This is achieved by specifying either the reflection density or the tristimulus values of a uniform (solid) printed ink film, and by specifying tolerances around an optical density at which various half-tone dot values should be reproduced. Within the international printing community such specifications are widely recognized and have become, in many cases, de facto printing standards. For magazine and periodical printing, SWOP (in the USA) and FIPP (in Europe) are widely recognized standards. For commercial printing, the specifications of FOGRA and PIRA are widely known in Europe. Specifications are also evolving for newspaper and heat-set web production. Future annexes to this International Standard may contain the colorimetric tristimulus values corresponding to these percent dot values when printed in accordance with a number of such printing specifications. Such data can be used as the basis for the conversion between ink values and tristimulus values.

It should be noted that any characterization of the process takes account of all steps involved in print production. Thus it includes production of the separations, any contacting operations which may be required and platemaking. All of the printing specifications as referred to above include recommendations for maintaining consistency of such operations to ensure that validity of a characterization is maintained.

For characterizing printing conditions which differ from the published specifications, two options exist. Either the large palette of colours can be printed and measured, or the process can be modelled analytically. The analytical modelling approach has the advantage that it requires far fewer colour measurements; the disadvantages lie in the accuracy of prediction. For many applications, a satisfactory compromise is achieved by using modelling for the modification of published data. This is discussed in more detail in the application notes.

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Choice of colour palette

It is generally agreed that measurement of a reasonably large number of colours is preferred for accurate characterization of any printing process. It is not possible to be precise about how many colours are required; the number will depend on many factors including the accuracy of colour rendition required, the uniformity of spacing of the samples in terms of colour, the type of modelling process used, and any nonlinear characteristics of a specific printing process. However, practical experience suggests that measuring all combinations of six levels each for cyan, magenta, yellow, and black, preferably weighted towards lower half-tone dot values, will frequently prove adequate. Generally, for higher levels of black, the number of samples may be considerably reduced since the colour difference between samples is very small. With the addition of single colour scales which contain extra values to assist in defining local nonlinearity, the accuracy obtained for most printing processes is adequate.

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A reduced-size data set may be used if:

— a less accurate characterization is adequate;

— the process can be modelled accurately by one of the well-known models listed in the application notes;

— the aim of the measurement is to seek small corrections to an already accurate characterization.

The advantages of this approach are that the measurement effort is substantially lower and that the file size of the data is greatly reduced. This can be advantageous when images are compressed although, in general, even the larger file is small compared to most images.

The proposal accepted for this International Standard defines a colour palette consisting of 928 combinations of cyan, magenta, yellow, and black ink values. It is this palette (hereafter called the extended ink value data set) which has been measured to provide colour characterization data on the major printing specifications.

Where such an extensive set of data is not required, a subset of this palette which consists of 182 colours (hereafter called the basic ink value data set) is specified. It provides data suited to a variety of modelling methods and generally provides excessive data for any specific method. It is sufficient for almost all published modelling methods.

For a characterization which cannot be achieved with the data sets defined in this International Standard, provision is made for a user-optional set of any size. The format of the data is defined in this International Standard.

It is anticipated that the basic data set will be the default file supplied in the header of image files to be exchanged, and that by prior agreement, one of the larger palettes may be provided when required. It is the intent of ANSI IT8/CGATS and of ISO/TC 130 to work with those organizations responsible for various printing definitions (SWOP, FOGRA, etc.) to develop tables of colour data that are agreed to be representative of the named printing conditions. When such data are available and published by ISO, such data can be referenced as "named" data. This means the published data should be used by the receiver and the file need not be sent. For many applications it is expected that the use of named data sets will suffice.

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Graphic technology — Prepress digital data exchange — Input data for characterization of 4-colour process printing

1 Scope

This International Standard defines an input data file, a measurement procedure and an output data format for use in characterizing any four-colour printing process.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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ISO/IEC 646:1991, *Information technology — ISO 7-bit coded character set for information interchange.*

ISO 12640:—[1], *Graphic technology — Prepress digital data exchange — Standard colour image data (SCID).*

ISO 13655:1996, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 CIE tristimulus values: Amounts of the three reference colour stimuli, in the CIE-specified trichromatic system, required to match the colour of the stimulus considered.

NOTE — In the 1931 CIE standard colorimetric system, the tristimulus values are represented by the symbols X, Y, Z.

3.2 colour gamut: Subset of perceivable colours reproducible by a device or medium.

3.3 half-tone dots: Dots which vary in spatial frequency or size thereby producing an image of tonal gradation. Half-tone dots are normally quantified by the percentage area they cover. Measurement of dot area is normally made on film separations and is derived from the Murray-Davies equation.

3.4 keyword value file: File that makes use of predefined keywords and data tables to exchange data in an open extensible manner.

1) To be published.

3.5 process colour printing: Reproducing colour images using three or more printing inks. The normal process inks consist of cyan, magenta, yellow, and black.

3.6 ink value: Digital file value which represents the amount of a colourant required in a rendering process. For the half-tone printing process this is equivalent to the dot area of the half-tone film expressed as a percentage.

3.7 white space: Space in a data file occupied by characters which do not print. Typical examples are space (position 2/0 of ISO/IEC 646), carriage return (position 0/13 of ISO/IEC 646), newline (position 0/10 of ISO/IEC 646), and tab (position 0/9 of ISO/IEC 646).

4 Requirements

4.1 Data set definition

Two sets of ink values are specified which span, with differing intervals, the colour space defined by combinations of cyan, magenta, yellow, and black dot area percentages. The basic data set, which is a subset of the extended data set, shall be the default set in the absence of any other information; the extended data set (or subsets of it) may be used if specified. The data is defined as digital data and does not exist as printed images (or sets of separations). However, the colorimetric values needed to produce the colour characterization data file may be determined by printing images which have been made from films containing half-tone values corresponding to the values in the ink value data set.

4.1.1 Basic ink value data set

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The cyan, magenta, yellow, and black ink values specified in this set, and their identification (ID) numbers, shall be as listed in table 1.

NOTE — The sample location information included in table 1 is based on the printing layout shown in figure A.1 and is included for information only.

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4.1.2 Extended ink value data set

The extended data set shall include the values of table 1 as well as those of table 2.

NOTE — The sample location information included in table 2 is based on the printing layout shown in figure A.1 and is included for information only.

Table 1 — Basic ink value data set

Sample		% Dot				Sample		% Dot				Sample		% Dot			
ID	Location*	C	M	Y	K	ID	Location*	C	M	Y	K	ID	Location*	C	M	Y	K
1	0A01	100	0	0	0	62	0E10	0	0	15	0	123	0J06	100	85	85	80
2	0A02	0	100	0	0	63	0E11	0	0	10	0	124	0J07	100	85	85	60
3	0A03	0	0	100	0	64	0E12	0	0	7	0	125	0J08	80	65	65	100
4	0A04	100	100	0	0	65	0E13	0	0	3	0	126	0J09	80	65	65	80
5	0A05	100	0	100	0	66	0F01	0	0	0	90	127	0J10	80	65	65	60
6	0A06	0	100	100	0	67	0F02	0	0	0	80	128	0J11	80	65	65	40
7	0A07	100	100	100	0	68	0F03	0	0	0	70	129	0J12	60	45	45	100
8	0A08	70	70	0	0	69	0F04	0	0	0	60	130	0J13	60	45	45	80
9	0A09	70	0	70	0	70	0F05	0	0	0	50	131	0K01	60	45	45	60
10	0A10	0	70	70	0	71	0F06	0	0	0	40	132	0K02	60	45	45	40
11	0A11	40	40	0	0	72	0F07	0	0	0	30	133	0K03	60	45	45	20
12	0A12	0	40	40	0	73	0F08	0	0	0	25	134	0K04	40	27	27	100
13	0A13	40	40	40	0	74	0F09	0	0	0	20	135	0K05	40	27	27	80
14	0B01	40	0	40	0	75	0F10	0	0	0	15	136	0K06	40	27	27	60
15	0B02	20	20	0	0	76	0F11	0	0	0	10	137	0K07	40	27	27	40
16	0B03	20	0	20	0	77	0F12	0	0	0	7	138	0K08	40	27	27	20
17	0B04	0	20	20	0	78	0F13	0	0	0	3	139	0K09	40	27	27	10
18	0B05	100	0	0	100	79	0G01	40	100	0	0	140	0K10	20	12	12	100
19	0B06	0	100	0	100	80	0G02	40	100	40	0	141	0K11	20	12	12	80
20	0B07	0	0	100	100	81	0G03	0	100	40	0	142	0K12	20	12	12	60
21	0B08	100	100	0	100	82	0G04	40	100	100	0	143	0K13	20	12	12	40
22	0B09	100	0	100	100	83	0G05	0	40	100	0	144	0L01	20	12	12	20
23	0B10	0	100	100	100	84	0G06	40	40	100	0	145	0L02	20	12	12	10
24	0B11	100	100	100	100	85	0G07	70	70	70	0	146	0L03	10	6	6	100
25	0B12	0	0	0	100	86	0G08	40	0	100	0	147	0L04	10	6	6	80
26	0B13	Paper				87	0G09	100	40	100	0	148	0L05	10	6	6	60
27	0C01	90	0	0	0	88	0G10	100	0	40	0	149	0L06	10	6	6	40
28	0C02	80	0	0	0	89	0G11	100	40	40	0	150	0L07	10	6	6	20
29	0C03	70	0	0	0	90	0G12	100	40	0	0	151	0L08	10	6	6	10
30	0C04	60	0	0	0	91	0G13	100	100	40	0	152	0L09	100	85	85	0
31	0C05	50	0	0	0	92	0H01	70	100	20	0	153	0L10	80	65	65	0
32	0C06	40	0	0	0	93	0H02	20	70	20	0	154	0L11	60	45	45	0
33	0C07	30	0	0	0	94	0H03	20	70	40	0	155	0L12	40	27	27	0
34	0C08	25	0	0	0	95	0H04	20	100	70	0	156	0L13	20	12	12	0
35	0C09	20	0	0	0	96	0H05	20	70	70	0	157	0M01	10	6	6	0
36	0C10	15	0	0	0	97	0H06	20	70	100	0	158	0M02	5	3	3	0
37	0C11	10	0	0	0	98	0H07	20	20	70	0	159	0M03	100	0	0	20
38	0C12	7	0	0	0	99	0H08	70	20	100	0	160	0M04	0	100	0	20
39	0C13	3	0	0	0	100	0H09	70	20	70	0	161	0M05	0	0	100	20
40	0D01	0	90	0	0	101	0H10	100	20	70	0	162	0M06	100	100	0	20
41	0D02	0	80	0	0	102	0H11	70	20	20	0	163	0M07	100	0	100	20
42	0D03	0	70	0	0	103	0H12	100	70	20	0	164	0M08	0	100	100	20
43	0D04	0	60	0	0	104	0H13	70	70	20	0	165	0M09	40	40	0	20
44	0D05	0	50	0	0	105	0I01	70	100	70	0	166	0M10	40	0	40	20
45	0D06	0	40	0	0	106	0I02	40	70	40	0	167	0M11	0	40	40	20
46	0D07	0	30	0	0	107	0I03	20	40	20	0	168	0M12	100	100	0	40
47	0D08	0	25	0	0	108	0I04	70	100	100	0	169	0M13	100	0	100	40
48	0D09	0	20	0	0	109	0I05	20	40	40	0	170	0N01	0	100	100	40
49	0D10	0	15	0	0	110	0I06	70	70	100	0	171	0N02	40	40	0	40
50	0D11	0	10	0	0	111	0I07	40	40	70	0	172	0N03	40	0	40	40
51	0D12	0	7	0	0	112	0I08	20	20	40	0	173	0N04	0	40	40	40
52	0D13	0	3	0	0	113	0I09	20	20	20	0	174	0N05	100	0	0	70
53	0E01	0	0	90	0	114	0I10	100	70	100	0	175	0N06	0	100	0	70
54	0E02	0	0	80	0	115	0I11	70	40	70	0	176	0N07	0	0	100	70
55	0E03	0	0	70	0	116	0I12	40	20	40	0	177	0N08	100	100	0	70
56	0E04	0	0	60	0	117	0I13	100	70	70	0	178	0N09	100	0	100	70
57	0E05	0	0	50	0	118	0J01	40	40	20	0	179	0N10	0	100	100	70
58	0E06	0	0	40	0	119	0J02	100	100	70	0	180	0N11	40	40	0	70
59	0E07	0	0	30	0	120	0J03	40	20	20	0	181	0N12	40	0	40	70
60	0E08	0	0	25	0	121	0J04	70	40	40	0	182	0N13	0	40	40	70
61	0E09	0	0	20	0	122	0J05	100	85	85	100						

* Location data is included for information only.

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Table 2 — Extended ink value data set

Sample		% Dot			
ID	Location*	C	M	Y	K
183	1A1	0	0	0	0
184	1A2	0	10	0	0
185	1A3	0	20	0	0
186	1A4	0	40	0	0
187	1A5	0	70	0	0
188	1A6	0	100	0	0
189	1B1	10	0	0	0
190	1B2	10	10	0	0
191	1B3	10	20	0	0
192	1B4	10	40	0	0
193	1B5	10	70	0	0
194	1B6	10	100	0	0
195	1C1	20	0	0	0
196	1C2	20	10	0	0
197	1C3	20	20	0	0
198	1C4	20	40	0	0
199	1C5	20	70	0	0
200	1C6	20	100	0	0
201	1D1	40	0	0	0
202	1D2	40	10	0	0
203	1D3	40	20	0	0
204	1D4	40	40	0	0
205	1D5	40	70	0	0
206	1D6	40	100	0	0
207	1E1	70	0	0	0
208	1E2	70	10	0	0
209	1E3	70	20	0	0
210	1E4	70	40	0	0
211	1E5	70	70	0	0
212	1E6	70	100	0	0
213	1F1	100	0	0	0
214	1F2	100	10	0	0
215	1F3	100	20	0	0
216	1F4	100	40	0	0
217	1F5	100	70	0	0
218	1F6	100	100	0	0
219	2A1	0	0	10	0
220	2A2	0	10	10	0
221	2A3	0	20	10	0
222	2A4	0	40	10	0
223	2A5	0	70	10	0
224	2A6	0	100	10	0
225	2B1	10	0	10	0
226	2B2	10	10	10	0
227	2B3	10	20	10	0
228	2B4	10	40	10	0
229	2B5	10	70	10	0
230	2B6	10	100	10	0
231	2C1	20	0	10	0
232	2C2	20	10	10	0
233	2C3	20	20	10	0
234	2C4	20	40	10	0
235	2C5	20	70	10	0
236	2C6	20	100	10	0
237	2D1	40	0	10	0
238	2D2	40	10	10	0
239	2D3	40	20	10	0
240	2D4	40	40	10	0
241	2D5	40	70	10	0
242	2D6	40	100	10	0
243	2E1	70	0	10	0
244	2E2	70	10	10	0
245	2E3	70	20	10	0
246	2E4	70	40	10	0
247	2E5	70	70	10	0
248	2E6	70	100	10	0
249	2F1	100	0	10	0
250	2F2	100	10	10	0
251	2F3	100	20	10	0
252	2F4	100	40	10	0
253	2F5	100	70	10	0
254	2F6	100	100	10	0
255	3A1	0	0	20	0
256	3A2	0	10	20	0
257	3A3	0	20	20	0
258	3A4	0	40	20	0
259	3A5	0	70	20	0
260	3A6	0	100	20	0
261	3B1	10	0	20	0
262	3B2	10	10	20	0
263	3B3	10	20	20	0
264	3B4	10	40	20	0
265	3B5	10	70	20	0
266	3B6	10	100	20	0
267	3C1	20	0	20	0
268	3C2	20	10	20	0
269	3C3	20	20	20	0
270	3C4	20	40	20	0
271	3C5	20	70	20	0
272	3C6	20	100	20	0
273	3D1	40	0	20	0
274	3D2	40	10	20	0
275	3D3	40	20	20	0
276	3D4	40	40	20	0
277	3D5	40	70	20	0
278	3D6	40	100	20	0
279	3E1	70	0	20	0
280	3E2	70	10	20	0
281	3E3	70	20	20	0
282	3E4	70	40	20	0
283	3E5	70	70	20	0
284	3E6	70	100	20	0
285	3F1	100	0	20	0
286	3F2	100	10	20	0
287	3F3	100	20	20	0
288	3F4	100	40	20	0
289	3F5	100	70	20	0
290	3F6	100	100	20	0
291	4A1	0	0	40	0
292	4A2	0	10	40	0
293	4A3	0	20	40	0
294	4A4	0	40	40	0
295	4A5	0	70	40	0
296	4A6	0	100	40	0
297	4B1	10	0	40	0
298	4B2	10	10	40	0
299	4B3	10	20	40	0
300	4B4	10	40	40	0
301	4B5	10	70	40	0
302	4B6	10	100	40	0
303	4C1	20	0	40	0
304	4C2	20	10	40	0
305	4C3	20	20	40	0
306	4C4	20	40	40	0
307	4C5	20	70	40	0
308	4C6	20	100	40	0
309	4D1	40	0	40	0
310	4D2	40	10	40	0
311	4D3	40	20	40	0
312	4D4	40	40	40	0
313	4D5	40	70	40	0
314	4D6	40	100	40	0
315	4E1	70	0	40	0
316	4E2	70	10	40	0
317	4E3	70	20	40	0
318	4E4	70	40	40	0
319	4E5	70	70	40	0
320	4E6	70	100	40	0
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322	4F2	100	10	40	0
323	4F3	100	20	40	0
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325	4F5	100	70	40	0
326	4F6	100	100	40	0
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331	5A5	0	70	70	0
332	5A6	0	100	70	0
333	5B1	10	0	70	0
334	5B2	10	10	70	0
335	5B3	10	20	70	0
336	5B4	10	40	70	0
337	5B5	10	70	70	0
338	5B6	10	100	70	0
339	5C1	20	0	70	0
340	5C2	20	10	70	0
341	5C3	20	20	70	0
342	5C4	20	40	70	0
343	5C5	20	70	70	0
344	5C6	20	100	70	0
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348	5D4	40	40	70	0
349	5D5	40	70	70	0
350	5D6	40	100	70	0
351	5E1	70	0	70	0
352	5E2	70	10	70	0
353	5E3	70	20	70	0
354	5E4	70	40	70	0
355	5E5	70	70	70	0
356	5E6	70	100	70	0
357	5F1	100	0	70	0
358	5F2	100	10	70	0
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361	5F5	100	70	70	0
362	5F6	100	100	70	0
363	6A1	0	0	100	0
364	6A2	0	10	100	0
365	6A3	0	20	100	0
366	6A4	0	40	100	0
367	6A5	0	70	100	0
368	6A6	0	100	100	0
369	6B1	10	0	100	0
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372	6B4	10	40	100	0
373	6B5	10	70	100	0
374	6B6	10	100	100	0
375	6C1	20	0	100	0
376	6C2	20	10	100	0
377	6C3	20	20	100	0
378	6C4	20	40	100	0
379	6C5	20	70	100	0
380	6C6	20	100	100	0
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382	6D2	40	10	100	0
383	6D3	40	20	100	0
384	6D4	40	40	100	0
385	6D5	40	70	100	0
386	6D6	40	100	100	0
387	6E1	70	0	100	0
388	6E2	70	10	100	0
389	6E3	70	20	100	0
390	6E4	70	40	100	0
391	6E5	70	70	100	0
392	6E6	70	100	100	0

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