INTERNATIONAL STANDARD

ISO 105-A11

First edition
2012-09-15

Textiles — Tests for colour fastness —

Part A11: Determination of colour fastness grades by digital imaging techniques

Textiles — Essais de solidité des coloris —

Partie A11: Détermination des degrés de solidité des coloris par des techniques d'imagerie numérique

Reference number
ISO 105-A11:2012(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 105-A11 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*.

ISO 105 consists of many parts designated by a part letter and a two-digit serial number (e.g. A01), under the general title *Textiles — Tests for colour fastness*. A complete list of these parts is given in ISO 105-A01.

Textiles — Tests for colour fastness —

Part A11: Determination of colour fastness grades by digital imaging techniques

1 Scope

This part of ISO 105 specifies the requirement for a digital imaging system for use in the methods specified in Annexes A and B for the determination of change in colour and staining by digital imaging techniques.

This method is not suitable for assessment of colour fastness to light as described in the ISO 105 B series, as these standards do not use grey scales to assess the specimen.

This part of ISO 105 describes apparatus, equipment settings and calibration for the assessment of

— change in colour, and

— staining.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 105-A01, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

CIE[1)] Publication S 012/E, *Standard method of assessing the spectral quality of daylight simulators for appraisal and measurement of colour*

CIE Publication 13.3, 1995, *Method of measuring and specifying the colour rendering properties of light sources*, 2nd edition

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
system grey
colour of the internal surfaces and apparatus that would normally be visible in a captured image

NOTE System grey shall be approximately between Munsell N5 and N7 and within CIELAB Lightness value of 50 or 70 ± 2,0 and CIELAB Chroma value not exceeding 2,5 in any hue direction under D65 and CIE 1964 standard colorimetric observer, respectively.

1) Commission Internationale d'Éclairage, Central Bureau, Kegelgasse 27, A-1030, Vienna, Austria.

3.2
verification chart[2)]
chart consisting of a series of colour patches of known colorimetric values

See Annex C.

3.3
system software
software required to control and operate the digital camera

3.4
white tile
tile whose colour is certified and traceable to a national standard

EXAMPLE Standard provided by the National Physical Laboratory in the UK.

3.5
operator-selected area
assessment for either staining or change in colour where the system operator manually selects both the location and size of the specimen test area for the reference and tested pieces

3.6
automatic grading
assessment for either staining or change in colour where the system software selects both the location and size of the specimen test area for the reference and tested pieces

4 Apparatus

4.1 General

The test apparatus consists of a verified digital camera (4.2)[3)], which is mounted on an illumination cabinet (4.3) that gives a controlled and consistent lighting environment. Specimens may be presented for grading individually, in multiples, or in one of a series of pre-defined templates depending on the type of test being carried out. The operator shall manually select the area to be assessed for grading.

Automatic grading (3.6) of specimens is permitted, provided that the grades produced by this method agree with those achieved by the Operator-Selected Area method (3.5).

The equipment shall be maintained and calibrated or verified, as appropriate, in accordance with the manufacturer's instructions.

4.2 Digital camera

4.2.1 Digital camera specification

4.2.1.1 Resolution

The digital camera shall have an effective resolution of not less than 3,0 M pixels.

---

2) A verification chart as described in 3.2 and Annex C is manufactured commercially as the DigiEye DigiTizer® series camera calibration chart and is available from VeriVide Limited, Quartz Close, Warrens Business Park, Enderby, Leicester, LE19 4SG, United Kingdom. Tel: +44 (0) 116 2847790; Email: enquiries@verivide.com This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3) The apparatus as described in Clause 4 with software as described in Annexes A and B manufactured commercially as the DigiEye® is available from VeriVide Limited, Quartz Close, Warrens Business Park, Enderby, Leicester, LE19 4SG, United Kingdom. Tel: +44 (0) 116 2847790; Email: enquiries@verivide.com. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

4.2.1.2 Optical zoom

The digital camera shall be capable of capturing the whole of the specimen assessment area in one image. In order for the image quality to be preserved, any adjustment of the focal length of the camera necessary to capture a suitable image shall be by optical means rather than digital.

4.2.1.3 PC connection

The camera connection to an external computer is done by using a suitable connection for image capture, download and camera control.

4.2.1.4 Camera settings

The system software (3.3) shall control all camera settings and shutter release operations needed for routine setup and imaging. The system software shall have a provision to store and set the operating settings required for different grading requirements.

4.2.2 Camera mounting

The digital camera shall be mounted on top of the illumination cabinet (4.3) at zero degrees to the normal with respect to the tested specimen. The camera mounting shall allow adjustment of the camera lens position to allow parallel alignment to the specimen assessment area.

The height of the camera above the assessment area is such that it will accommodate the required focal length of the lens and capture the whole of the defined assessment area within the image.

4.2.3 Camera verification

4.2.3.1 General

The function of the camera verification is to verify the camera output for each pixel in an image in terms of CIE XYZ data. The verification is then applied to all subsequent images used for digital grading. The camera calibration is done using a digital verification chart as described in Annex C.

4.2.3.2 Verification interval

The camera shall be verified

— at system start-up,

— if the camera settings are changed, and

— at the manufacturer’s recommended verification time interval.

4.2.3.3 Verification time

The time and date of the current verification shall be recorded in the system software and be accessible to the user. The system software shall indicate to the user when the recommended verification period has expired.

4.2.3.4 Verification performance

The verification performance of the digital method is expressed in terms of repeatability and accuracy. The results shall be expressed in terms of the median and maximum CIEDE2000 colour difference between the known and measured values of the digital verification chart. The procedures to conduct these tests are described below.

The system software shall store a summary of the verification performance for the current verification such that it is easily retrievable by the user.

4.2.3.5 Accuracy test

The digital imaging apparatus (4.2) shall be verified within the time period as specified by the manufacturer or at 8 hourly intervals, whichever is sooner.

For each colour patch in the verification chart, the CIEDE2000 colour difference value shall be calculated between the prediction from the digital method and the measurement from a spectrophotometer which has been calibrated with white tiles (3.4) certified as traceable to a national standard, such as the National Physical Laboratory in the UK.

The median and maximum CIEDE2000 colour difference values shall be recorded in the system to represent the accuracy performance.

The accuracy shall be deemed satisfactory if

— CIEDE2000 maximum is less than 5,0, and

— CIEDE2000 median is less than 1,0.

4.2.3.6 Repeatability test

The repeatability test shall be carried out at frequent intervals in accordance with the manufacturer's instructions.

Ten consecutive measurements of the verification chart shall be as defined in Annex C. All colour patches used in the verification routine shall be measured and recorded by the system.

The arithmetic mean values of the CIELAB L*, a*, b*, C* and h attributes shall be calculated for each colour patch.

The CIEDE2000 colour difference values shall be calculated between the mean and each individual measurement for each colour patch.

The median of the CIEDE2000 colour difference values shall be calculated for each colour patch.

The median and maximum CIEDE2000 colour difference values shall be reported to represent the repeatability performance.

The repeatability shall be deemed satisfactory if

— CIEDE2000 maximum is less than 1,0, and

— CIEDE2000 median is less than 0,4.

4.3 Illumination cabinet

4.3.1 General

The cabinet shall

— have opaque walls to exclude ambient light,

— be of sufficient area to accommodate the samples being assessed,

— be of a height to provide even illumination, and

— have the lighting configuration and internal surfaces such that the illumination of the specimen area is by diffuse illumination with no direct illumination from the light source.

The digital camera shall be mounted as described in 4.2.2.

4.3.2 Illumination

4.3.2.1 Quality

The illumination shall be provided by a D65 simulator to give an illumination level of not less than 400 lx and not greater than 900 lx at the assessment area surface.

The spectral output of the D65 simulator shall be of sufficient quality to achieve a 'B' or better rating in the visible region for CIE illuminant D65 and CIE 'x' and 'y' chromaticity coordinates of 0,313 and 0,329 ± 0,03 when measured conforming to CIE S 012/E. The CIE General Colour Rendering Index of the D65 simulator shall be greater than 95 conforming to CIE 13.3.

In order to maintain the illumination quality, the D65 simulator shall be changed after a period not exceeding 12 months, or in accordance with the manufacturer's instructions.

4.3.2.2 Evenness

The variation of illumination level across the specimen assessment area shall not be greater than 4 % of the total lux output.

4.3.2.3 D65 simulator

The quality of the D65 simulator and the lux levels of the cabinet illumination shall be checked to ensure conformance to 4.3.3.

The D65 simulator requires a minimum of 10 min to reach a stable operating condition after switch-on prior to use.

A D65 simulator warm-up procedure shall occur when the D65 simulator has been turned off for a period exceeding 10 min.

4.3.3 Specimen assessment area

The size of the assessment area for specimen measurements shall not be greater than 300 mm x 210 mm. The centre of the assessment area shall be located at the centre of a captured image.

The surface of the assessment area shall be a low gloss (less than 2 gloss units) finish and of sufficient durability to maintain its colour tolerance during normal use and cleaning.

4.3.4 Specimen masks

If specimen masks are used, they shall be of system grey (3.1) and of thickness that does not cast a shadow onto the assessment area of any specimen.

Annex A
(normative)

Assessment of the change in colour of a test specimen

A.1 General principle

The original and tested specimens are measured. The area to be measured may be selected by either of the 'Operator-Selected Area' (3.5) or the 'Automatic Grading' methods (3.6) defined in Clause 3 of this part of ISO 105. The colour difference between them is calculated in CIEDE2000 units and converted to a grey scale rating for change in colour by means of an equation.

A.2 Terms and definitions

A.2.1
original specimen
reference specimen for the assessment of change in colour as defined in ISO 105-A01

A.2.2
tested specimen
specimen which has been subjected to a fastness test for change in colour

A.2.3
uniform coloured area
area that is visually perceived as uniform in colour over the area under test

NOTE Effects such as texture, gloss or other physical characteristics that may influence the visual colour appearance shall be disregarded for the purpose of this definition.

A.2.4
non-uniform coloured area
area that is visually perceived as non-uniform in colour over the area under test

NOTE Effects such as texture, gloss or other physical characteristics that may influence the visual colour appearance shall be disregarded for the purpose of this definition.

A.2.5
multi-coloured test specimen
specimen comprised of more than one coloured region within the selected test area

A.3 Apparatus

Use the digital imaging apparatus as defined and verified or calibrated as described in Clause 4 and Annex C.

A.4 Test secimen preparation

The original and tested specimens are mounted using staples on visually uniform white paper or card.

A.5 Procedure

A.5.1 Single colour test specimens

A.5.1.1 Measure the colour of the original specimen.

A.5.1.2 Measure the corresponding colour in the tested specimen. For uniformly coloured areas the arithmetical mean shall be employed in the calculations.

If any colour in the test specimen is visually non-uniform, then by agreement with both parties the area of worst colour change may be determined. In this case, the area is selected by the 'Operator-Selected Area' method (3.5) and shall correspond to the area of worst colour change, rather than the whole of the selected test area. If the "Operator-Selected Area" method is used, it shall be stated in the report.

A.5.2 Multi-colour test specimens

For each colour in the original specimen, repeat the procedure for single-colour test specimens as outlined in A.5.1.

Each tested colour for multi-coloured test specimens shall be reported separately.

A.5.3 Software

The software shall calculate the CIEDE2000 colour difference, ΔE_{00}, and the magnitude of the CIEDE2000 lightness difference, ΔL_{00}, between the average values of all the pixels of the selected areas for the original and the tested specimen, to two decimal places.

A.5.4 Calculation of grades

A.5.4.1 Calculated grade

Calculate, to two decimal places, the grey scale rating for change in colour (GRC) using the following equation

$$\text{GRC} = 0{,}88 + 3{,}89e^{-0{,}2\Delta E_{\text{GRC}}}$$

where

$$\Delta E_{\text{GRC}} = \Delta E_{00} - 0{,}52\sqrt{\Delta E_{00}^2 - \Delta L_{00}^2}$$

and ΔE_{00} calculated with $k_L = 1{,}0$, $k_{\text{C}} = 0{,}5$

k_L = lightness weighting parameter for DE2000;

k_{C} = chroma weighting parameter for DE2000.

A.5.4.2 Determination of grey scale rating

Determine from Table A.1 the grey scale rating for change in colour to be reported.

Table A.1 — Grey scale rating for change in colour (GRC)

Calculated GRC	Reported GRC
5,00 to 4,75	5
4,74 to 4,25	4 – 5
4,24 to 3,75	4
3,74 to 3,25	3 – 4
3,24 to 2,75	3
2,74 to 2,25	2 – 3
2,24 to 1,75	2
1,74 to 1,25	1 – 2
< 1,25	1

A.6 Test report

The test report of the colour fastness test concerned shall include the following information:

a) the number of this part of ISO 105, i.e ISO 105-A11:2012;

b) the date of assessment;

c) the grey scale rating for change in colour (instrumental) from Table A.1; for multicoloured samples, each colour shall be reported individually;

d) any deviations from this method.

A.7 Performance

The combination of the digital imaging apparatus described in this part of ISO 105 and the fastness formula for assessing change in colour in A.5.4 performs well in predicting fastness grading. According to the study by Cui et al, the typical error of prediction is approximately 0,40 grades, which is much more accurate than the inter-observer (technician) error of 0,61 and between-lab error of 0,53 grades (see Annex D).

Annex B
(normative)

Assessment of staining of a test specimen

B.1 Principle

The original and tested adjacent specimens are measured. The colour difference between them is calculated in CIEDE2000 units and converted to a grey scale rating for staining by means of an equation.

B.2 Apparatus

Use the digital imaging apparatus as defined and calibrated as described in Clause 4 and Annex C.

B.3 Test specimen

The original and tested adjacent specimens are mounted using staples on a visually uniform white paper or card. The original may be initially measured and the results stored in order to compare with the subsequent measurements of the tested adjacent specimen which has been subjected to a fastness test. This can be carried out within one calibration period provided the adjacent specimen is from the same batch of standard adjacent material.

B.4 Procedure

B.4.1 Single-colour test specimens

B.4.1.1 Measure the original specimen. In the case of a multifibre adjacent specimen, each component shall be individually measured. It may be desirable to use stored data for the original specimen provided the data is obtained from the same batch of standard material.

Measure the corresponding component of the tested adjacent specimen.

B.4.1.2 For visually uniformly stained areas, the arithmetical mean shall be employed in the calculations. If any colour in the tested adjacent specimen is visually non-uniform, then by agreement with both parties the area of worst staining may be determined. In this case, the area selected by the ‘Operator-Selected Area’ method (3.5) shall correspond to the area of worst staining, rather than the whole of the selected test area. If the Operator-Selected Area method is used, it shall be stated in the test report.

B.4.2 Multi-colour test specimens

Where it is possible to visually determine the staining corresponding to each colour within a multi-coloured test specimen, the staining results for each colour shall be reported separately. For each colour in the original specimen, repeat the procedure for single-colour test specimens as outlined in B.4.1 and report each tested colour separately.

Where multi-coloured specimens produce non-discreet staining, the whole of the test area shall be assessed as a single colour by following the procedure outlined in B.4.1.

B.5 Calculation

B.5.1 Calculate the CIEDE2000 colour difference, ΔE_{00}, and the magnitude of the CIEDE2000 lightness difference, ΔL_{00}, between the average of all the pixels of the selected area for the original specimen and the tested adjacent specimen, to two decimal places. Calculations shall be performed using the CIE 1964 (or 10°) standard colorimetric observer and illuminant D65.

B.5.2 Calculate to two decimal places, the grey scale rating for staining (GRS) using the following equation:

$$\text{GRS} = -0{,}061\Delta E_{\text{GRS}} + 2{,}474(1 + e^{-0{,}191\Delta E_{\text{GRS}}})$$

where

$$\Delta E_{\text{GRS}} = \Delta E_{00} - 0{,}423\sqrt{\Delta E_{00}^2 - \Delta L_{00}^2}$$

and ΔE_{00} calculated with $k_L = 1{,}0$, $k_{\text{C}} = 0{,}5$

k_L = lightness weighting parameter for DE2000;

k_{C} = chroma weighting parameter for DE2000.

B.5.3 Determine from Table B.1 the grey scale rating for staining to be reported.

Table B.1 — Grey scale rating for staining

Calculated GRS	**Reported GRS**
5,00 to 4,75	5
4,74 to 4,25	4 – 5
4,24 to 3,75	4
3,74 to 3,25	3 – 4
3,24 to 2,75	3
2,74 to 2,25	2 – 3
2,24 to 1,75	2
1,74 to 1,25	1 – 2
< 1,25	1

B.6 Test report

The test report of the colour fastness test concerned shall include the following information:

a) the number of this part of ISO 105, i.e. ISO 105-A11:2012;

b) the date of assessment;

c) the grey scale rating for staining (instrumental) from Table B.1, for each adjacent fabric or in the case of multifibre adjacent fabric, each component and for multi-coloured samples, each colour individually;

d) any deviations from this method.

B.7 Performance

The combination of the digital imaging apparatus (see Clause 4 and Annex C) and the fastness formula for assessing staining in B.4 performs well in predicting fastness grading. The results of the interlaboratory trials (see Annex D and Cui et al) are summarized below.

— Typical error:

— Digital instrument: 0,29 grey scale units

— Visual observer: 0,45 grey scale units

Annex C
(normative)

Verification chart

C.1 Purpose

The purpose of the verification chart is to characterize the RGB response of the digital camera in terms of CIE XYZ in order to facilitate colour measurement of any pixel within the image.

C.2 Number of colours in verification chart

The chart shall have a minimum of 150 patches of different colours to ensure good measurement accuracy across all the areas of the CIE colour space.

C.3 Reference measurement of colours used to produce the verification chart

Each colour patch in a batch of charts shall be measured using a diffuse/8 colour spectrophotometer in specular-included, UV-excluded mode. The instrument shall be maintained according to manufacturer's instructions and at least annually, its performance checked against a series of certifiable calibration tiles of known reflectance values traceable to national standards.

C.4 Verification chart measurement data

The reflectance data of each colour patch shall be recorded and stored with the system software. This data shall be used as reference data for each camera verification.

At each scheduled maintenance of the apparatus, a new verification chart and its corresponding spectral data file shall be replaced.

C.5 Verification chart specification

The colours for a batch of charts shall be measured before cutting to ensure verification accuracy across batches.

The size of the patches of each colour shall be sufficient to allow the software to locate the individual colours and make a representative measurement; typically approximately 10 mm x 10 mm has been found suitable.

The mounting of the colour patches to the chart matrix shall be done in such a way as not to contaminate or degrade the coloured surface.

Each colour patch shall be separated by a black border and the border may be covered by a template mask to provide additional strength and protection to the verification chart.

C.6 Verification chart location

The verification chart is located centrally within the sample assessment area on the cabinet base. The top of the chart is positioned such that it will appear at the top of the captured image.

C.7 Verification chart replacement

The normal lifetime of a verification chart is 12 months in normal use, after which it is replaced. However, the chart shall be replaced should it become damaged or otherwise unusable.

The corresponding spectral data file shall be replaced at the same time.

Annex D
(informative)

Summary of report and conclusions of international trial for determination of colour fastness grades by digital imaging techniques

D.1 Introduction

The full report is given in Document ISO TC 38/SC 1 N2476. This is a brief summary of the report and its conclusions.

D.2 Scope of trial

The interlaboratory trial considered

a) visual assessment:

   — variation between assessor,

   — variation between laboratory;

b) performance of different fastness formulae for both staining and change in shade;

c) inter-instrument agreement.

D.3 Methodology

D.3.1 Laboratories and assessors

The interlaboratory trial involved 7 laboratories and 17 assessors (technicians): 3 each in test laboratories in China, Korea, Sweden and France, 1 in the USA and 2 in the UK and Germany. However, it should be noted that while individual assessments were made by the 3 Korean technicians, only average results were submitted for analysis. Hence, there are 14 individual assessors' data available. In all cases, the assessors were highly trained and experienced in visual assessment of colour-fastness results.

D.3.2 Samples

There were 72 specimens assessed for staining and 48 pairs of specimens assessed for change in shade. Samples of dyed fabrics showing differences in lightness, chroma, hue or a combination of any of these differences were produced to give 72 shade-change samples. 8 sets of multifibre samples were dyed to give different levels of staining onto different parts of the multifibre. All samples were mounted onto visually uniform white cards and given unique identifying numbers. Laboratories were asked to grade these specimens in their usual manner and to report the results in a matrix provided.

D.3.3 Instrumental assessment

Colour measurements were carried out by a GretagMacbeth 7000A[4)] spectrophotometer and a DigiEye[5)] system (N2476 Cui *et al.* 2003a). The measuring conditions for CE7000A were small aperture, and inclusion of UV and specular component.

4) GretagMacbeth 7000A is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

5) DigiEye is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

D.3.4 Data analysis

A number of comparisons between two sets of data are made in the report. A Root-Mean-Square(RMS) equation is used as a measure to indicate the disagreement between two sets of data in terms of grade of assessment.

D.4 Key findings and conclusions

1) Both between-assessor and between-lab variations for assessing the fastness of shade change are large, exceeding commercially acceptable 0,5 grade. The variations are smaller for assessing fastness of staining.

2) The GRC formula significantly outperformed the ISO shade change formula. These findings confirm the earlier UK trial (N 2476 ref Cui, 2004b).

3) The GRS formula slightly outperformed the ISO staining formula.

4) In general, the instrumental measurement results of either the digital or spectrophotometric shade change method have a smaller variation than those for staining. The latter measurements were based on much smaller and less uniform specimens than the former measurement.

5) Both spectrophotometric and digital measurements gave a very similar performance in predicting assessor panel results for assessing shade change results. However, the digital method gave assessments closer in correlation to assessor panel results for assessing staining than the spectrophotometric method.

6) The results show a high level of repeatability and reproducibility in the digital grade. In addition, the object assessment removes any commercial influences that may impinge on a subjective visual assessment. The results show that digital assessment provides an impartial grade of the specimens under test.

7) Appendix 2 of N 2476 provides information about why the GRC formula is based on CIEDE2000 rather than CIELAB.

Bibliography

[1] ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

[2] ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

[3] ISO 105 (all parts), *Textiles — Tests for colour fastness*

[4] ASTM D1729-96, *Standard Practice for Visual Evaluation of Colors and Color Differences of Diffusely-Illuminated Opaque Materials*

[5] British Standard 1006, Method of test for *colourfastness tests for textiles and leather, T series*

[6] CIE Publication 15-2004, *Colorimetry*, 3rd Edition

[7] CIE Publication 142-2001, Improvement to Industrial Colour-Difference Evaluation

[8] CUI G.H., LUO M.R., RIGG B., RHODES P.A., DAKIN J. Grading textile fastness. Part III. Development of a new fastness formula for assessing change in colour. *Coloration Technology*. 2004, **120** pp. 226–230

ICS 59.080.01

Price based on 16 pages