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Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

Indian Standard

MANIPULATING INDUSTRIAL ROBOTS — APPLICATION ORIENTED TEST — SPOT WELDING

ICS 25.040.30

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NATIONAL FOREWORD

This Indian Standard which is identical with ISO/TR 11032 : 1994 'Manipulating industrial robots — Application oriented test — Spot welding' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of Industrial and Production Automation Systems and Robotics Sectional Committee (BP 18) and approval of the Basic and Production Engineering Division Council.

This standard does not include the development of individual standards themselves but rather the establishment of common frame work, in terms of a reference model to assist future standards developments.

The text of the ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'Technical Report' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standards</th>
<th>Corresponding Indian Standards</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 9787 : 1990 Manipulating industrial robots — Coordinate systems and motions</td>
<td>IS 14663 : 1999 Manipulating industrial robotics — Coordinate systems and motions</td>
<td>do</td>
</tr>
</tbody>
</table>

At present there is no Indian Standard on subject covered under ISO 5830. The technical committee responsible for the preparation of this standard reviewed the provisions of the above mentioned ISO standards and decided about the acceptable for use in conjunction with this standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

MANIPULATING INDUSTRIAL ROBOTS —
APPLICATION ORIENTED TEST —
SPOT WELDING

1 Scope

This Technical Report uses spot welding motion sequences to represent typical spot welding applications. Cycle time values are used as a measure of spot welding performance. A presentation format is provided for consistent presentation of test results.

The term Spot welding used in this standard means Resistance spot welding (RPW) according to the vocabulary accepted by the International Institute of Welding (IIS).

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 International 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 listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5830:1984, Resistance spot welding - Male electrode caps
ISO 8373:1994, Manipulating industrial robots - Vocabulary
ISO 9283:1990, Manipulating industrial robots - Performance criteria and related testing methods
ISO 9409-1:1988, Manipulating industrial robots - Mechanical interfaces - Part 1: Circular (form A)
ISO 9787:1990, Manipulating industrial robots - Coordinate systems and motions

3 Definitions

For the purpose of this Technical Report, the definitions given in ISO 8373 apply.
4 Description of application

Spot welding robots are used for joining sheet metal, for example in the car industry. Typical thicknesses of the sheets are from 0.5 mm to 2.0 mm.

Spot welding is performed when the robot is not moving. The movements between spots are typically in the range of 40 - 500 mm. Spots are often placed in groups and motions between these can demand major reorientations of the welding gun.

Robots used for spot welding typically have a rated load between 50 and 150 kg. Robots with a lower rated load can also be applied.

In order to reduce damages on robot and flanges, spot welding guns handled by robots are typically equipped with an equalizing system, which takes care of variability in the robot performance, sheet metal position and variations in electrode tip length.

The spot welding equipment typically consists of one of the following solutions:

a) Spot welding gun, mass: 30 - 120 kg, mounted on a robot.
   Transformer 35 - 200 kVA, mass: 50 - 100 kg, ceiling or wall mounted, or standing on the floor with cables (kickless) connected to the spot welding gun.

b) Spot welding gun, mass: 30 - 120 kg, mounted on a robot.
   Transformer 35 - 200 kVA, mass 50 - 200 kg, placed on the robot arm and connected to the welding gun with an integrated media supply (current, water, air) or cables (kickless).

c) Spot welding gun with integrated transformer, mass: 50 - 150 kg, mounted on a robot.
   Transformer 20 - 80 kVA.
   Media supply (current, water, air) along the robot arm or hanging from above.

d) Poke welding gun with a single electrode, mass: 10-30 kg, mounted on a robot. The second electrode provided is stationary.

e) Stationary spot welding gun. The spot welding gun is fixed and the robot is handling the object about the gun.

The welding controller is installed remote or integrated in the robot controller.

Typical communication sequences for spot weldings are shown in Figure 1.

Settings of welding parameters are for instance dependant upon the quality of cables between transformer and the welding gun, sheet numbers and materials, the electrodes and the weld quality demands.

Special demands on the robot for spot welding applications are the ability to make quick movements especially over short distances, to perform rapid reorientations, and have good performance in positioning and controlling the welding gun. It is also important to have smooth motions in order to achieve a short cycle time.

Robotic spot welding involves both static and dynamic forces that will affect the workpiece and these forces will have to be taken into account when optimizing cycle times.

The media supply (current, water, air) to the welding gun (e.g kickless cable) creates dynamic forces that the robot shall withstand.
Gun Electrode Displacement of Gun Stroke

Robot motion

Robot motion

Robot Velocity

Gun motion

A + B + C = Robot motion and deceleration
B = Communication time
(Weld order from robot to welding timer, processing output signal to valve for closing gun)
C = Robot is decelerating into stop position and gun has started to close
F = Cooling time, often used for communication after Weld current clear
C + D + E + F = Time for activated valve (Squeeze, Weld Current and Cooling times)
F + G = Communication and robot delay time
G + H = Time for gun opening stroke
H + I = Robot acceleration and motion time
a = Event when robot gives weld order to welding timer
b = Event when valve for gun closing is activated
c = Event when robot stops
d = Event when the gun is closed and when the required electrode force is obtained
e = Event when the robot start to prepare next action
f = Event when command to valve "Open gun" is given
g = Event when robot motion is allowed to start (when gun has opened enough).
The event of "g" may occur after "h".
h = Event when gun is open

Figure 1 - Communication sequence for spot welding
5 Description of test

The purpose of the tests in this report is to evaluate cycle time performance. The cycle time tests selected include typical position sequences, see table 1.

These tests complement the test performance criteria described in ISO 9283. Those tests applicable for spot welding robots are summarized in ISO 9283 Amendment 1 as follows:

- Unidirectional pose accuracy
- Unidirectional pose repeatability
- Distance accuracy
- Distance repeatability
- Pose stabilization time
- Pose overshoot
- Drift of pose characteristics
- Minimum positioning time
- Static compliance

The user has to decide which of these tests, and also which of the tests described in this report, are valid for a specific application.

The testing conditions as described in ISO 9283 (clauses 6.1 through 6.3) shall be applied.

A delay of 0.6 seconds shall be programmed to simulate welding time at each position. No robot motion is allowed during the programmed delay.

<table>
<thead>
<tr>
<th>Table 1 - Overview of tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>Test 1a (Test plate):</td>
</tr>
<tr>
<td>Measuring sequence 1:1</td>
</tr>
<tr>
<td>Measuring sequence 1:2</td>
</tr>
<tr>
<td>Test 1b (Test plate):</td>
</tr>
<tr>
<td>Measuring sequence 1:1</td>
</tr>
<tr>
<td>Measuring sequence 1:2</td>
</tr>
<tr>
<td>Test 2 (Test beam):</td>
</tr>
<tr>
<td>Measuring sequence 2:1</td>
</tr>
</tbody>
</table>
5.1 Test 1

This test consists of two different measuring sequences. For details see 8.3. The first sequence 1:1 is an application test showing large reorientations and the second sequence 1:2 is an application test showing short motions.

5.1.1 Test 1.a

This test shall be performed with the test plate and the test tool described in 7.1 and 7.3 and in accordance with the test procedure described in 8.

All the points shall be reached, otherwise test 1.b shall be applied.

5.1.2 Test 1.b

Test 1.b is an alternative to test 1.a for those robots which are unable to reach all test poses. The test plate shall be placed in the most optimized position and angle for the robot.

Measuring sequences as in Test 1.a.

5.3 Test 2

Test 2 is an application test showing the performance of the robot when it is moving the test tool long distances between the test poses.

This test consists of one sequence 2:1. See 8.4.

This test shall be performed with the test beam and the test tool described in 7.2 and 7.3 and in accordance with the test procedure described in 8.

6 Deviation in the test from a real application

The deviations from real applications are:

- The spot welding gun is replaced by a specified test tool and a measurement equipment e.g. light sensor.
- The welding time is simulated by using a fixed programmed delay.
- The welding current is not applied during the test.
- Hoses etc for cooling water and air, cables for welding current and signals are not installed. This means that reaction forces from such sources are not considered in the test.
- The case "d" (see clause 4) poke welding is not included in this test.
- The case "e" (see clause 4) with a stationary welding gun is not included in this test.
7 Specification of test apparatus

7.1 Test plate

The test plate, used for tests 1.a and 1.b, shall be made according to the drawings in Annex A. Figure 2 shows a view of the assembled test plate.

The plate has flanges and obstacles mounted perpendicularly to the plate surface. The robot has to pass the obstacles as described in 8.3.

Each pose on the flanges shall be provided with a hole Ø 2.0 mm.

In test 1.a, the sides of the test plate shall be parallel to the base coordinate system (x and y) of the robot. See figure 3.

The plate centre shall be placed in xz-plane, i.e. the x- and z- coordinates of the plate centre are selectable. The test plate centre shall be placed as close as possible to the centre of the cube defined in ISO 9283 such that all test points can be reached.

The coordinates of the plate centre shall be reported in the test results.
In test 1.b, the test plate can be placed and orientated for optimum robot operation.

The location coordinates of the test plate (plate centre, position W5 and W6) shall be reported in the test results.

Figure 3 - Test plate and robot with test tool
7.2 Test beam

The test beam, used for test 2, shall be made in accordance with the drawings in Annex B.

The test beam shall be mounted on the test plate according to Annex B during test 2.

The test beam shall be equipped with a flange mounted perpendicularly to the plate.

Each pose on the flange shall be provided with a hole Ø 2.0 mm.

The test beam centre shall be placed in xz-plane, i.e. the x- and z- coordinates of the beam centre are selectable. See figure 4. The test beam centre shall be placed as close as possible to the centre of the cube defined in ISO 9283 such that all test points can be reached.

The coordinates of the test beam centre shall be reported in the test results.

Figure 4 - Test beam and robot with test tool
7.3 Test tool

The test tool consists of a fixture which holds the test load and the light sensor shown in figure 5.

The light sensor is positioned to simulate the direction of the welding electrodes.

The entire mass of the test tool shall be either 30, 60, 80, 100 or 120 kg. The heaviest possible test load, within the rated load of the robot, shall be used for the test. Figure 5 and table 2 describe the test tool with load offset and tool centre point (TCP) offset.

The light beam characteristic of the light sensor shall be parallel. The light beam diameter at the receiver shall not exceed 0.5 mm. Examples of light sensors are given in Annex 1.

The arrow marked on the test tool in figure 5 corresponds to the orientation indicated on the test plate and the test beam. See Annex C, D and E.

![Figure 5 - Test tool](image)

<table>
<thead>
<tr>
<th>Test loads</th>
<th>Centre of gravity</th>
<th>Light beam</th>
</tr>
</thead>
<tbody>
<tr>
<td>30, 60, 80, 100, 120</td>
<td>Axial -340, Radial -100</td>
<td>Axial 340, Radial 320</td>
</tr>
</tbody>
</table>
8 Description of measurement procedure

8.1 General principle

The general principle of the measurement is shown in figure 6.

When the robot reaches the programmed area the first signal which shall be recorded is "Attained pose" coming from the robot controller. The next signal will be "Light beam inside hole" coming from the light sensor. Any oscillation of the robot, bigger than the diameter of the hole, will be visible in the graph.

The end of the spot sequence is the combined signal of "Robot movement start" and "Light beam outside hole".

The total time for activated stop signal shall be reported in the test results. The total time for activated stop signal is the accumulated time between the signal "Attained pose" and "Robot movement start" for all poses.

Figure 6 - Measurement principle
8.2 Time measuring

Program the robot until the light sensor output signal indicates an "In position condition" for at least 0.6 seconds continuously for each test pose.

8.3 Procedure for tests 1.a and 1.b

Orientation of the test tool during tests 1.a and 1.b is shown in Annex C and E. (Note the direction of the arrows in each pose.)

The posed light beam shall be perpendicular (± 5°) to the flanges and inside the holes.

The test tool is in start position Pstart = w1 + (0, 0, 200) mm.

A start signal is given via I/O-signal to both the robot and the recording device.

Measuring sequence 1:1 (large reorientations):

Pstart
w1
Repeat w2, w3, w4 ... w 8 ; 3 times
w1
Pstart

Measuring sequence 1:2 (short motions):

Pstart
Repeat w2, w 9, w 10 .... w 20,
w2, w 20, w 19 .... w 9 ; 3 times
Pstart

A stop signal is given to the recording device by the robot via output signal after the robot has stopped in its final programmed position, Pstart.

The test tool shall pass obstacle "A" in z-direction (up and over the obstacle) and pass obstacle "B" with a movement in the xy-plane (around the obstacle at the w1 side). See Annex C.

8.4 Procedure for test 2

Orientation of the test tool during test 2 is shown in Annex D. (Note the direction of the arrows in each pose.)

The posed light beam shall be perpendicular (± 5°) to the flange and inside the holes.

The test tool is in start position Pstart = w1 + (0, 0, 200) mm.

A start signal is given via I/O-signal to both the robot and recording device.

Measuring sequence 2:1 (long distances):

Pstart
Repeat wbl ... wb 10; 3 times
Pstart

A stop signal is given by the robot via output signal to the recording device after the robot has stopped in its final programmed position, Pstart.
9 Specification of adjustments of robot controller parameters for the application

9.1 Robot controller parameters

The robot controller parameter values shall be set to those recommended by the robot manufacturer for spot welding. The procedure and settings shall be reported in the test results to allow repeating of the test.

The test report shall mention if the robot controller parameters are the same as in the basic test ISO 9283.

9.2 Program structure

Data to be reported is listed in clause 10, Presentation of results.

The structure of the test program, programmed constants and mode (pose-to-pose control or linear control) shall be reported in the test results.

It shall be possible to execute the test program step-by-step.

Programming methods used and not described in the manual shall be explained in the test results.
## 10 Presentation of results

The test results shall be described as below:

<table>
<thead>
<tr>
<th>ROBOT</th>
<th>Control system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td></td>
</tr>
<tr>
<td>Type:</td>
<td></td>
</tr>
<tr>
<td>Model No:</td>
<td></td>
</tr>
<tr>
<td>Serial No:</td>
<td></td>
</tr>
<tr>
<td>Mounting orientation: (eg floor, wall, ceiling)</td>
<td></td>
</tr>
<tr>
<td>Software version:</td>
<td></td>
</tr>
<tr>
<td>System parameters same as in basic test ISO 9283: Yes/No</td>
<td></td>
</tr>
<tr>
<td>Test tool mass: ..... kg</td>
<td></td>
</tr>
</tbody>
</table>

Test location (site):

Type of test: Test with test tool according to 7.3 or test with test gun according to F2.2.

REMARK: Results from the two types of test shall not be compared since the test conditions are not the same.

Physical environment

Ambient temperature:

Abnormal conditions: (Note)
Test 1.a

- Cycle time, sequence 1:1: ........... s
- Cycle time, sequence 1:2: ........... s
- Location of test plate centre: X ........... mm
  Z ........... mm
- Total time for activated stop signal ........... s

- Programmed constants (variables, work frame, tool center point, etc.)
- Programming mode, eg manual, linear, explicit etc.
- Electrical connections and communication
- Program list (logic including positions) and explanation of programming philosophy
- System constants
- Videotape showing the measuring sequence 1:1 and 1:2 should be available.
- Description of the light sensor, time recording instrument and signal types (if applied)
- Description of the simulated welding equipment, ie. transformer mass and position (if applied)
- Comments:
Test 1.b

<table>
<thead>
<tr>
<th>- Cycle time, sequence 1:1:</th>
<th>.......... s</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cycle time, sequence 1:2:</td>
<td>.......... s</td>
</tr>
<tr>
<td>- Location of test plate centre:</td>
<td>X .......... mm</td>
</tr>
<tr>
<td></td>
<td>Y .......... mm</td>
</tr>
<tr>
<td></td>
<td>Z .......... mm</td>
</tr>
</tbody>
</table>

Position w5

| - Position number(s) not possible to reach: | .......... |

Position w6

| - Total time for activated stop signal | .......... s |

| - Programmed constants (variables, work frame, tool center point, etc.) | |
| - Programming mode, eg manual, linear, explicit etc. | |
| - Electrical connections and communication | |
| - Program list (logic including positions and explanation of programming philosophy): | |
| - System constants | |
| - Videotape showing the measuring sequence 1:1 and 1:2 should be available: | |
| - Description of the light sensor, time recording instrument and signal types (if applied) | |
| - Description of the simulated welding equipment, i.e. transformer mass and position (if applied) | |
| - Comments: | |
Test 2

- Cycle time, sequence 2:1:
- Location of test beam centre:

<table>
<thead>
<tr>
<th>Location of Test Beam Centre</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>\ldots</td>
<td>\ldots mm</td>
</tr>
<tr>
<td>\ldots</td>
<td>\ldots</td>
<td>\ldots</td>
</tr>
<tr>
<td>\ldots</td>
<td>\ldots</td>
<td>\ldots</td>
</tr>
</tbody>
</table>

- Total time for activated stop signal 
- Programmed constants (variables, work frame, tool center point, etc.)
- Programming mode, e.g. manual, linear, explicit etc
- Electrical connections and communication
- Program list (logic including positions) and explanation of programming philosophy:
- System constants
- Videotape showing the measuring sequence should be available:
- Description of the light sensor, time recording instrument and signal types (if applied)
- Description of the simulated welding equipment, i.e. transformer mass and position (if applied)
- Comments:

11 Other comments
ANNEX A - TEST PLATE DRAWINGS

(Informative)
ANNEX A - TEST PLATE DRAWINGS
(Informative)
ANNEX B - TEST BEAM DRAWINGS
(Informative)
ANNEX C - TEST POSES FOR TEST 1

(Informative)
ANNEX D - TEST POSES FOR TEST 2

(Informative)
ANNEX E - ORIENTATION OF THE TEST TOOL

(Informative)
ANNEX F

Spot welding test using a welding gun as an alternative to the light sensor equipment

Introduction

This informative Annex of ISO/TR 11032 provides a method to extend the basic test procedure to more closely represent a typical spot welding application.

In general this test differs from the normative test as follows:

- The test includes the ability of the robot to control opening and closing of the welding gun.
- Reaction forces from the robot and the contact with the work piece that may affect the robot are included.
- The test includes spot welding conditions when programming.
- The test does not allow as detailed evaluation of the test results as the test procedure in the normative part.

To perform this alternative test most of the test procedures described in the normative part will be the same.

Listed below are the modified test procedures to perform this alternative test and the corresponding clause numbers in the normative part.

F.1 Deviation in the test from a real application (6)
- The spot welding time is simulated by using a fixed time for pressure valve activation.
- The welding gun including equalizing system is specially designed for this test (if not using a standard spot welding gun).

F.2 Specification of test apparatus (7)

F.2.1 Test plate and test beam (7.1-7.2)

The poses on the flanges shall be marked out with a circle, target diameter 4 mm larger than the diameter of electrode tip, instead of the hole.

The flanges shall be exchangeable and shall be exchanged between each measuring sequence.

Force limitation is defined in clause F.3.1.
F.2.2 Test gun (7.3)

A standard spot welding gun or a specially designed test gun shall be used for this test.

For the specially designed test gun there shall be five different masses (30, 60, 80, 100 or 120 kg) based on the same body design. The heaviest gun, within the rated load of the robot, shall be used for this test. Annex G describes the three test guns with load offset and TCP offset.

The test gun may be mounted to the robot with an adapter plate when required. The use of adapter plate shall be reported in the test results.

The arrow marked on the welding gun drawings corresponds to the orientation indicated on the test plate and the test beam. Annex H.

The gun closing time and the time to obtain the specified electrode force shall be $0.30 \pm 0.05$ seconds.

The gun opening time shall be $0.20 \pm 0.05$ seconds.

The gun opening gap shall be 50 mm.

The electrode force shall be 2.0 kN.

These closing and opening times for a single stroke shall be checked and calibrated before each test. If these time specifications cannot be achieved, the influence from the closing and opening times shall be reported in the test results.

\[ C+D \] = Time for gun to close and to obtain the specified electrode force ($0.30 \pm 0.05$ seconds)

\[ C+D+E+F \] = Minimum time for activated valve 0.60 seconds (to be reported in the test results)

\[ G+H \] = Time for gun to open ($0.20 \pm 0.05$ seconds)

Figure F.1 - Gun electrode displacements motion
F.3 Description of measurement procedure (8)

F.3.1 Force limitation (8.1)

The maximum permitted force between the robot and the target flanges is 150 N for forces parallel to the plate plane.

The maximum permitted displacement of the plate is ± 1.0 mm parallel to the plate plane.

No electrode tip marks are allowed outside the marked circles.

F.3.2 Time measuring (8.2)

A time measuring device triggered by an electrical signal shall be used.

F.3.3 Procedure for tests 1.a and 1.b (8.3)

The orientation of the test gun during test 1.a and 1.b shall be the same as shown in Annex C and E in the normative part. Note the direction of the arrows in each pose.

The closed electrode tips shall be perpendicular (± 5°) to the flanges and inside the marked circles.

A start signal is given via I/O-signal to both the robot and the timing device.

A stop signal is given to the timing device by the robot via output signal after the robot has stopped in its final programmed position Pstart.

F.3.4 Procedure for test 2 (8.4)

The orientation of the test gun during test 2 shall be the same as shown in Annex D in the normative part. Note the direction of the arrows in each pose.

The closed electrode tips shall be perpendicular (± 5°) to the flanges and inside the marked circles.

A start signal is given via I/O-signal to both the robot and the timing device.

A stop signal is given to the timing device by the robot via output signal after the robot has stopped in its final programmed position Pstart.

F.4 Presentation of results (10)

The same format as in the normative part shall be used for presentation of the test results and extended with the time for activated valve per spot (C + D + E + F in figure F.1).
The test gun body mass shall be 30 kg. Additional deadweight up to 60, 80, 100 and 120 kg resp.

ISO 9409-1 - A 100
Mechanical interface.
(Pitch Circle Ø 100)

Electrode caps ISO 5830 type

Centre of gravity

Lead tare

EQURLIZING DEVICE FIXED TO GUN BRACKET

CENTRE OF GRAVITY

Min. 320

Min. 256

Min. 53

Stroke 50

110 BORE + 0.50 STROKE D. A. CYLINDER

(Informative)
ANNEX H - ORIENTATION OF THE TEST GUN

(Informative)
## ANNEX I - LIGHT SENSORS

*(Informative)*

<table>
<thead>
<tr>
<th>Example of light sensors</th>
<th>Sensor manufacturers</th>
<th>Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser-Lichtschranke LLS 0500</td>
<td>Laser Components GmbH</td>
<td>Am Weidegrund 10 Postfach 265 8038 Grobenzell/Mü GERMANY PHONE (0 81 42) 50 02-0 FAX (0 81 42) 90 97</td>
</tr>
<tr>
<td>Einweg-Lichtschranke LS 66</td>
<td>Leuze electronic GmbH + Co</td>
<td>Postfach 1111 D-7311 Owen-Teck GERMANY PHONE (0 70 21) 57 30</td>
</tr>
<tr>
<td>Laser-Einweglichtschranke</td>
<td>Wenglor sensoric GmbH</td>
<td>Narzissenstrassen 3 W-7992 Tettnang GERMANY PHONE (0 75 42) 53 99-0 FAX (0 75 42) 53 99 88</td>
</tr>
</tbody>
</table>

**REMARK:** This list may be extended if additional light sensors will be known.
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This Indian Standard has been developed from Doc : No. BP 18 (0055).

Amendments Issued Since Publication

<table>
<thead>
<tr>
<th>Amend No.</th>
<th>Date of Issue</th>
<th>Text Affected</th>
</tr>
</thead>
</table>

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Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:
Central: Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110 002
323 76 17, 323 38 41

Eastern: 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi
KOLKATA 700 054
337 84 99, 337 85 61
337 86 26, 337 91 20

Northern: SCO 335-336, Sector 34-A, CHANDIGARH 160 022
60 38 43
60 20 25

Southern: C.I.T. Campus, IV Cross Road, CHENNAI 600 113
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Printed at Prabhat Offset Press, New Delhi-2