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**Information technology — Data interchange  
on 12,7 mm, 384-track magnetic tape  
cartridges — Ultrium-1 format**

*Technologies de l'information — Échange de données sur cartouches à  
bande magnétique 12,7 mm, 384 pistes — Format Ultrium-1*

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## Contents

### Section 1 – General

|             |                                                 |          |
|-------------|-------------------------------------------------|----------|
| <b>1</b>    | <b>Scope</b>                                    | <b>1</b> |
| <b>2</b>    | <b>Conformance</b>                              | <b>1</b> |
| <b>2.1</b>  | <b>Magnetic tape cartridge</b>                  | <b>1</b> |
| <b>2.2</b>  | <b>Generating system</b>                        | <b>1</b> |
| <b>2.3</b>  | <b>Receiving system</b>                         | <b>1</b> |
| <b>3</b>    | <b>Normative references</b>                     | <b>1</b> |
| <b>4</b>    | <b>Terms and definitions</b>                    | <b>2</b> |
| <b>4.1</b>  | <b>Access Point</b>                             | <b>2</b> |
| <b>4.2</b>  | <b>algorithm</b>                                | <b>2</b> |
| <b>4.3</b>  | <b>algorithmically processed data</b>           | <b>2</b> |
| <b>4.4</b>  | <b>a.c. erase</b>                               | <b>2</b> |
| <b>4.5</b>  | <b>Average Signal Amplitude</b>                 | <b>2</b> |
| <b>4.6</b>  | <b>back surface</b>                             | <b>2</b> |
| <b>4.7</b>  | <b>Beginning of Tape (BOT)</b>                  | <b>2</b> |
| <b>4.8</b>  | <b>Beginning of Wrap (BOW)</b>                  | <b>2</b> |
| <b>4.9</b>  | <b>bit</b>                                      | <b>2</b> |
| <b>4.10</b> | <b>bit cell</b>                                 | <b>2</b> |
| <b>4.11</b> | <b>Broad Band Signal-to-Noise Ratio (BBSNR)</b> | <b>2</b> |
| <b>4.12</b> | <b>byte</b>                                     | <b>2</b> |
| <b>4.13</b> | <b>cartridge</b>                                | <b>2</b> |
| <b>4.14</b> | <b>Channel bit</b>                              | <b>3</b> |
| <b>4.15</b> | <b>Codeword</b>                                 | <b>3</b> |
| <b>4.16</b> | <b>Codeword Pair</b>                            | <b>3</b> |
| <b>4.17</b> | <b>Codeword Quad (CQ)</b>                       | <b>3</b> |
| <b>4.18</b> | <b>CQ Set</b>                                   | <b>3</b> |
| <b>4.19</b> | <b>cyclic redundancy check (CRC) character</b>  | <b>3</b> |
| <b>4.20</b> | <b>Data Set</b>                                 | <b>3</b> |
| <b>4.21</b> | <b>Data Set Information Table (DSIT)</b>        | <b>3</b> |
| <b>4.22</b> | <b>End of Data (EOD)</b>                        | <b>3</b> |
| <b>4.23</b> | <b>End of Tape (EOT)</b>                        | <b>3</b> |
| <b>4.24</b> | <b>End of Wrap (EOW)</b>                        | <b>3</b> |
| <b>4.25</b> | <b>Error Correcting Code (ECC)</b>              | <b>3</b> |
| <b>4.26</b> | <b>File Mark</b>                                | <b>3</b> |
| <b>4.27</b> | <b>flux transition position</b>                 | <b>3</b> |
| <b>4.28</b> | <b>flux transition spacing</b>                  | <b>3</b> |
| <b>4.29</b> | <b>forward tape motion</b>                      | <b>3</b> |
| <b>4.30</b> | <b>header</b>                                   | <b>3</b> |
| <b>4.31</b> | <b>Housekeeping Data Set</b>                    | <b>3</b> |
| <b>4.32</b> | <b>logical forward</b>                          | <b>4</b> |
| <b>4.34</b> | <b>Logical Point</b>                            | <b>4</b> |
| <b>4.35</b> | <b>magnetic tape</b>                            | <b>4</b> |
| <b>4.36</b> | <b>Master Standard Reference Tape (MSRT)</b>    | <b>4</b> |
| <b>4.37</b> | <b>LTO Cartridge Memory (LTO CM)</b>            | <b>4</b> |
| <b>4.38</b> | <b>Optimum Recording Current</b>                | <b>4</b> |

|                                                   |                                                             |          |
|---------------------------------------------------|-------------------------------------------------------------|----------|
| 4.39                                              | physical end of tape                                        | 4        |
| 4.40                                              | physical forward                                            | 4        |
| 4.41                                              | physical reverse                                            | 4        |
| 4.42                                              | pre-record condition                                        | 4        |
| 4.43                                              | processed data                                              | 4        |
| 4.44                                              | Processed Record                                            | 4        |
| 4.45                                              | Processing (Compression)                                    | 4        |
| 4.46                                              | Protected Record                                            | 4        |
| 4.47                                              | Record                                                      | 5        |
| 4.48                                              | recorded element                                            | 5        |
| 4.50                                              | Reprocessing (Decompression)                                | 5        |
| 4.51                                              | reverse tape motion                                         | 5        |
| 4.52                                              | run length limited encoding (RLL)                           | 5        |
| 4.53                                              | Secondary Standard Reference Tape (SSRT)                    | 5        |
| 4.54                                              | servo acquisition region                                    | 5        |
| 4.55                                              | Standard Reference Amplitude (SRA)                          | 5        |
| 4.56                                              | Symbol                                                      | 5        |
| 4.57                                              | Synchronised Codeword Quad (SCQ)                            | 5        |
| 4.58                                              | Test Recording Density (TRD)                                | 5        |
| 4.59                                              | wrap                                                        | 5        |
| 4.60                                              | write equalisation                                          | 5        |
| 4.61                                              | (1,7) RLL code                                              | 5        |
| 5                                                 | Conventions and notations                                   | 6        |
| 5.1                                               | Representation of numbers                                   | 6        |
| 5.2                                               | Dimensions                                                  | 6        |
| 5.3                                               | Names                                                       | 6        |
| 5.4                                               | Alphanumeric string encoding                                | 6        |
| 6                                                 | Acronyms                                                    | 6        |
| 7                                                 | Environment and safety                                      | 6        |
| 7.1                                               | Cartridge and tape testing environment                      | 7        |
| 7.2                                               | Cartridge operating environment                             | 7        |
| 7.3                                               | Cartridge storage environment                               | 7        |
| 7.4                                               | Tape tension                                                | 7        |
| 7.5                                               | Safety                                                      | 7        |
| 7.6                                               | Flammability                                                | 7        |
| 7.7                                               | Transportation                                              | 7        |
| <b>Section 2 - Requirements for the Cartridge</b> |                                                             | <b>8</b> |
| 8                                                 | Dimensional and Mechanical Characteristics of the Cartridge | 8        |
| 8.1                                               | Elements of the cartridge                                   | 8        |
| 8.2                                               | Reference Planes of the case                                | 8        |
| 8.3                                               | Dimensions of the case                                      | 8        |
| 8.3.1                                             | Overall dimension                                           | 8        |
| 8.3.2                                             | Reference points for reference planes                       | 9        |
| 8.3.3                                             | Positioning notches                                         | 10       |
| 8.3.4                                             | Handling notches                                            | 10       |
| 8.3.5                                             | Mis-insertion protection                                    | 11       |
| 8.3.6                                             | Stacking features                                           | 11       |
| 8.3.7                                             | Label area of the rear side                                 | 12       |
| 8.3.8                                             | Central window                                              | 12       |
| 8.3.9                                             | Sliding door                                                | 12       |
| 8.3.10                                            | Case opening                                                | 12       |
| 8.4                                               | Write-inhibit mechanism                                     | 13       |

|                                                         |                                                                  |           |
|---------------------------------------------------------|------------------------------------------------------------------|-----------|
| 8.5                                                     | Flexibility of the case                                          | 13        |
| 8.5.1                                                   | Requirements                                                     | 13        |
| 8.5.2                                                   | Procedure                                                        | 13        |
| 8.6                                                     | Tape reel                                                        | 13        |
| 8.6.1                                                   | Locking mechanism                                                | 13        |
| 8.6.2                                                   | Axis of rotation of the reel                                     | 14        |
| 8.6.3                                                   | Reel flanges                                                     | 14        |
| 8.6.4                                                   | Metallic insert                                                  | 14        |
| 8.6.5                                                   | Toothed rim                                                      | 15        |
| 8.6.6                                                   | Hub of the reel                                                  | 15        |
| 8.6.7                                                   | Relative positions of hub and case                               | 15        |
| 8.6.8                                                   | Characteristics of the toothed rim                               | 15        |
| 8.7                                                     | Magnetic tape                                                    | 16        |
| 8.7.1                                                   | Tape wind                                                        | 16        |
| 8.7.2                                                   | Wind tension                                                     | 16        |
| 8.7.3                                                   | Circumference of the tape reel                                   | 16        |
| 8.7.4                                                   | Moment of inertia                                                | 16        |
| 8.8                                                     | Leader pin assembly                                              | 17        |
| 8.8.1                                                   | Leader pin assembly dimensions                                   | 17        |
| 8.8.2                                                   | Leader tape attachment to leader pin assembly                    | 17        |
| 8.8.3                                                   | Latching the leader pin assembly in the case                     | 17        |
| 8.8.4                                                   | Mechanism and tape exit keepout area                             | 18        |
| 8.9                                                     | LTO CM                                                           | 18        |
| 8.10                                                    | Areas reserved for cartridge presence sensing                    | 19        |
| 8.11                                                    | Handling grips and insertion indicator                           | 19        |
| 8.11.1                                                  | Side grips                                                       | 19        |
| 8.11.2                                                  | Insertion indicator                                              | 19        |
| 8.11.3                                                  | Top grip                                                         | 19        |
| 8.11.4                                                  | Bottom grip                                                      | 20        |
| 8.12                                                    | Pad Printing Areas                                               | 20        |
| 8.13                                                    | Opacity                                                          | 20        |
| <b>Section 3 - Requirements for the Unrecorded Tape</b> |                                                                  | <b>35</b> |
| 9                                                       | Mechanical, physical and dimensional characteristics of the tape | 35        |
| 9.1                                                     | Materials                                                        | 35        |
| 9.2                                                     | Tape length                                                      | 35        |
| 9.2.1                                                   | Length of magnetic tape                                          | 35        |
| 9.2.2                                                   | Length of leader tape                                            | 35        |
| 9.2.3                                                   | Length of splicing tape                                          | 35        |
| 9.3                                                     | Tape Width                                                       | 35        |
| 9.3.1                                                   | Width of magnetic tape                                           | 35        |
| 9.3.2                                                   | Width of leader tape                                             | 35        |
| 9.3.3                                                   | Width of splicing tape                                           | 35        |
| 9.3.4                                                   | Procedure                                                        | 36        |
| 9.4                                                     | Tape Thickness                                                   | 36        |
| 9.4.1                                                   | Procedure                                                        | 36        |
| 9.5                                                     | Longitudinal curvature                                           | 36        |
| 9.5.1                                                   | Procedure                                                        | 36        |

|               |                                                                                                                      |           |
|---------------|----------------------------------------------------------------------------------------------------------------------|-----------|
| <b>9.6</b>    | Edge Quality                                                                                                         | <b>36</b> |
| <b>9.6.1</b>  | Edge deviation                                                                                                       | <b>36</b> |
| <b>9.7</b>    | Tape flatness                                                                                                        | <b>37</b> |
| <b>9.7.1</b>  | Cupping                                                                                                              | <b>37</b> |
| <b>9.7.2</b>  | Curl/Twist                                                                                                           | <b>38</b> |
| <b>9.8</b>    | Coating adhesion                                                                                                     | <b>38</b> |
| <b>9.8.1</b>  | Procedure                                                                                                            | <b>38</b> |
| <b>9.9</b>    | Layer-to-layer adhesion                                                                                              | <b>38</b> |
| <b>9.9.1</b>  | Requirement                                                                                                          | <b>38</b> |
| <b>9.9.2</b>  | Procedure                                                                                                            | <b>39</b> |
| <b>9.10</b>   | Coefficient of friction                                                                                              | <b>40</b> |
| <b>9.10.1</b> | Requirement                                                                                                          | <b>40</b> |
| <b>9.10.2</b> | Procedure for the measurement of the dynamic friction between the magnetic surface and the back surface              | <b>40</b> |
| <b>9.10.3</b> | Procedure for the measurement of the dynamic friction between the back surface and SS-310 stainless steel            | <b>40</b> |
| <b>9.10.4</b> | Procedure for the measurement of the dynamic friction between the magnetic surface and AlO <sub>2</sub> /TiC ceramic | <b>40</b> |
| <b>9.11</b>   | Surface quality                                                                                                      | <b>41</b> |
| <b>9.11.1</b> | Surface roughness                                                                                                    | <b>41</b> |
| <b>9.12</b>   | Abrasivity                                                                                                           | <b>41</b> |
| <b>9.13</b>   | Tensile strength                                                                                                     | <b>41</b> |
| <b>9.13.1</b> | Breaking strength                                                                                                    | <b>41</b> |
| <b>9.13.2</b> | Offset yield strength                                                                                                | <b>41</b> |
| <b>9.14</b>   | Longitudinal compliance                                                                                              | <b>41</b> |
| <b>9.14.1</b> | Procedure                                                                                                            | <b>42</b> |
| <b>9.15</b>   | Residual elongation                                                                                                  | <b>42</b> |
| <b>9.15.1</b> | Requirement                                                                                                          | <b>42</b> |
| <b>9.15.2</b> | Procedure                                                                                                            | <b>42</b> |
| <b>9.16</b>   | Flexural rigidity                                                                                                    | <b>42</b> |
| <b>9.16.1</b> | Requirement                                                                                                          | <b>42</b> |
| <b>9.16.2</b> | Procedure                                                                                                            | <b>42</b> |
| <b>9.17</b>   | Transverse dimensional stability                                                                                     | <b>42</b> |
| <b>9.18</b>   | Electrical resistance of coated surfaces                                                                             | <b>42</b> |
| <b>9.18.1</b> | Requirement                                                                                                          | <b>42</b> |
| <b>9.18.2</b> | Procedure                                                                                                            | <b>42</b> |
| <b>10</b>     | Magnetic Recording Characteristics                                                                                   | <b>43</b> |
| <b>10.1</b>   | General                                                                                                              | <b>43</b> |
| <b>10.2</b>   | Test conditions                                                                                                      | <b>43</b> |
| <b>10.3</b>   | Optimum Recording Current                                                                                            | <b>44</b> |
| <b>10.4</b>   | Signal amplitude                                                                                                     | <b>44</b> |
| <b>10.5</b>   | Resolution                                                                                                           | <b>44</b> |
| <b>10.6</b>   | Overwrite                                                                                                            | <b>44</b> |
| <b>10.6.1</b> | Requirement                                                                                                          | <b>44</b> |

|                  |                                                     |           |
|------------------|-----------------------------------------------------|-----------|
| 10.7             | Ease of erasure                                     | 44        |
| 10.8             | Broad Band Signal-to-Noise Ratio                    | 44        |
| 10.8.1           | Requirement                                         | 44        |
| 10.9             | Tape quality                                        | 44        |
| 10.9.1           | Missing pulses                                      | 44        |
| 10.9.2           | Missing pulse zone                                  | 45        |
| <b>Section 4</b> | <b>Requirements for an Interchanged Tape</b>        | <b>45</b> |
| 11               | Method of recording servo bands                     | 45        |
| 11.1             | General                                             | 45        |
| 11.2             | Servo bands                                         | 45        |
| 11.2.1           | Servo stripes                                       | 46        |
| 11.2.2           | Servo bursts                                        | 46        |
| 11.2.3           | Servo frames                                        | 46        |
| 11.2.4           | Servo signal amplitude                              | 47        |
| 11.2.5           | Servo signal polarity                               | 47        |
| 11.2.6           | Servo defects                                       | 48        |
| 11.3             | Servo frame encoding                                | 48        |
| 11.3.1           | Method of encoding position and manufacturer's data | 48        |
| 11.3.2           | LPOS word construction                              | 50        |
| 11.3.3           | Tape manufacturer encoding                          | 51        |
| 11.3.4           | Cross tape identification                           | 53        |
| 11.4             | Servo band location                                 | 53        |
| 11.5             | Servo band pitch                                    | 53        |
| 11.6             | Nominal servo locations                             | 53        |
| 11.7             | Long-term average servo location                    | 53        |
| 12               | Method of recording data tracks                     | 54        |
| 12.1             | Physical recording density                          | 54        |
| 12.2             | Nominal bit cell length                             | 54        |
| 12.3             | Long-term average bit cell length                   | 54        |
| 12.4             | Short-term Average Bit Cell Length (STA)            | 54        |
| 12.5             | Rate of change of the STA                           | 54        |
| 12.6             | Bit shift                                           | 54        |
| 12.7             | Recording performance test conditions               | 54        |
| 12.8             | Track sequence addressing                           | 54        |
| 12.9             | Location of data tracks                             | 55        |
| 12.10            | Track width                                         | 55        |
| 12.11            | Adjacent track pitch                                | 56        |
| 12.12            | Azimuth                                             | 56        |
| 12.13            | Total character skew                                | 56        |
| 12.14            | Channel Layout                                      | 56        |
| 13               | Format                                              | 57        |
| 13.1             | General                                             | 57        |
| 13.2             | Protected Record                                    | 58        |
| 13.3             | Processed Protected Record Sequence                 | 59        |
| 13.3.1           | Control Symbols                                     | 59        |
| 13.3.2           | End Marker                                          | 60        |
| 13.3.3           | Access Points                                       | 60        |
| 13.3.4           | Alignment and append points                         | 61        |

|                |                                             |           |
|----------------|---------------------------------------------|-----------|
| <b>13.4</b>    | <b>Data Set</b>                             | <b>61</b> |
| <b>13.4.1</b>  | <b>Format Identification Data Set (FID)</b> | <b>61</b> |
| <b>13.4.2</b>  | <b>User Data Set</b>                        | <b>62</b> |
| <b>13.4.3</b>  | <b>EOD Data Set</b>                         | <b>62</b> |
| <b>13.4.4</b>  | <b>Housekeeping Data Set</b>                | <b>62</b> |
| <b>13.5</b>    | <b>Data Set Information Table (DSIT)</b>    | <b>62</b> |
| <b>13.5.1</b>  | <b>Drive Manufacturer Use</b>               | <b>63</b> |
| <b>13.5.2</b>  | <b>Drive Manufacturer Use C1</b>            | <b>63</b> |
| <b>13.5.3</b>  | <b>Reserved</b>                             | <b>63</b> |
| <b>13.5.4</b>  | <b>Drive Manufacturer's Identity</b>        | <b>63</b> |
| <b>13.5.5</b>  | <b>Data Set number</b>                      | <b>63</b> |
| <b>13.5.6</b>  | <b>Valid Data Length</b>                    | <b>64</b> |
| <b>13.5.7</b>  | <b>Access Point Offset</b>                  | <b>64</b> |
| <b>13.5.8</b>  | <b>Total Records</b>                        | <b>64</b> |
| <b>13.5.9</b>  | <b>Total File Marks</b>                     | <b>65</b> |
| <b>13.5.10</b> | <b>Record Count</b>                         | <b>65</b> |
| <b>13.5.11</b> | <b>File Mark Count</b>                      | <b>66</b> |
| <b>13.5.12</b> | <b>Thread Count</b>                         | <b>66</b> |
| <b>13.5.13</b> | <b>Data Set Type</b>                        | <b>66</b> |
| <b>13.5.14</b> | <b>Data Set Flags</b>                       | <b>67</b> |
| <b>13.5.15</b> | <b>Thread Write Pass</b>                    | <b>67</b> |
| <b>13.5.16</b> | <b>Tape Write Pass</b>                      | <b>67</b> |
| <b>13.6</b>    | <b>ECC</b>                                  | <b>67</b> |
| <b>13.6.1</b>  | <b>Sub Data Set</b>                         | <b>68</b> |
| <b>13.6.2</b>  | <b>C1 Sub Data Set</b>                      | <b>68</b> |
| <b>13.6.3</b>  | <b>ECC Encoded Sub Data Set</b>             | <b>69</b> |
| <b>13.6.4</b>  | <b>Codeword Pair designation</b>            | <b>70</b> |
| <b>13.7</b>    | <b>Codeword Quads (CQ)</b>                  | <b>70</b> |
| <b>13.7.1</b>  | <b>Codeword Pair Header</b>                 | <b>71</b> |
| <b>13.7.2</b>  | <b>First Codeword Pair</b>                  | <b>72</b> |
| <b>13.7.3</b>  | <b>Second Codeword Pair</b>                 | <b>72</b> |
| <b>13.8</b>    | <b>Allocation of CQs to Logical Tracks</b>  | <b>73</b> |
| <b>13.9</b>    | <b>Data randomisation</b>                   | <b>74</b> |
| <b>13.10</b>   | <b>RLL encoding</b>                         | <b>74</b> |
| <b>14</b>      | <b>Recording of data on tape</b>            | <b>75</b> |
| <b>14.1</b>    | <b>Synchronised Data Set</b>                | <b>75</b> |
| <b>14.1.1</b>  | <b>Data Set Separator (DSS)</b>             | <b>75</b> |
| <b>14.1.2</b>  | <b>VFO Field 1</b>                          | <b>76</b> |
| <b>14.1.3</b>  | <b>VFO Field 2</b>                          | <b>76</b> |
| <b>14.1.4</b>  | <b>Synchronised Codeword Quad (SCQ)</b>     | <b>76</b> |
| <b>14.2</b>    | <b>Write equalisation bit encoding</b>      | <b>77</b> |
| <b>14.3</b>    | <b>Writing cells on tape</b>                | <b>77</b> |
| <b>15</b>      | <b>Regions on tape</b>                      | <b>77</b> |
| <b>15.1</b>    | <b>Logical Points and regions</b>           | <b>77</b> |
| <b>15.2</b>    | <b>Calibration Region</b>                   | <b>79</b> |
| <b>15.3</b>    | <b>User Data Region</b>                     | <b>79</b> |
| <b>15.4</b>    | <b>Interrupted Data Sets</b>                | <b>79</b> |
| <b>15.5</b>    | <b>Repeated CQ Sets</b>                     | <b>80</b> |

|              |                           |           |
|--------------|---------------------------|-----------|
| <b>15.6</b>  | Amble CQs                 | <b>80</b> |
| <b>15.7</b>  | Beginning of Wrap (BOW)   | <b>81</b> |
| <b>15.8</b>  | End of Wrap (EOW)         | <b>81</b> |
| <b>15.9</b>  | Appending and Overwriting | <b>81</b> |
| <b>15.10</b> | Servo Tracking Faults     | <b>82</b> |

## **Annexes**

|          |                                                   |            |
|----------|---------------------------------------------------|------------|
| <b>A</b> | - Measurement of Bit Shift                        | <b>83</b>  |
| <b>B</b> | - Measurement of Broad Band Signal-to-Noise Ratio | <b>84</b>  |
| <b>C</b> | - Tape Abrasivity Measurement Procedure           | <b>86</b>  |
| <b>D</b> | - LTO Cartridge Memory                            | <b>88</b>  |
| <b>E</b> | - Flexural Rigidity Procedure                     | <b>107</b> |
| <b>F</b> | - LTO CM electrical interface                     | <b>109</b> |
| <b>G</b> | - Recommendations for transportation              | <b>126</b> |
| <b>H</b> | - Inhibitor Tape                                  | <b>127</b> |
| <b>I</b> | - Vendor code lists                               | <b>128</b> |

## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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

ISO/IEC 22050 was prepared by ECMA (as ECMA-319) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Annexes A to F form a normative part of this International Standard. Annexes G to I are for information only.

# Information technology — Data interchange on 12,7 mm, 384-track magnetic tape cartridges — Ultrium-1 format

## Section 1 — General

### 1 Scope

This International Standard specifies the physical and magnetic characteristics of magnetic tape cartridges, using magnetic tape 12,65 mm wide so as to provide physical interchange of such cartridges between drives. It also specifies the quality of the recorded signals, the recording method and the recorded format, thereby allowing data interchange between drives by means of such cartridges. The format supports variable length Logical Records, high speed search, and the use of a registered algorithm for data compression.

This International Standard specifies four types of cartridges depending on the length of tape contained in the case. These four types are referred to as Type A, Type B, Type C and Type D; their nominal capacity is 100 Gbytes, 50 Gbytes, 30 Gbytes and 10 Gbytes, respectively.

NOTE - One Gbyte contains 1 000 000 000 bytes.

Information interchange between systems also requires, at a minimum, agreement between the interchange parties upon the interchange code(s) and the specification of the structure and labeling of the information on the interchanged cartridge.

This International Standard shall be used only in conjunction with ISO/IEC 22091.

Together with a standard for volume and file structure, e.g. Standard ISO 1001, this document provides for full data interchange between data processing systems.

### 2 Conformance

#### 2.1 Magnetic tape cartridge

A tape cartridge shall be in conformance with this International Standard if it meets all the mandatory requirements specified herein. The tape requirements shall be satisfied throughout the extent of the tape.

#### 2.2 Generating system

A system generating a magnetic tape cartridge for interchange shall be in conformance with this International Standard if all the recordings that it makes meet the mandatory requirements of this International Standard.

#### 2.3 Receiving system

A system receiving a magnetic tape cartridge for interchange shall be in conformance with this International Standard if it is able to handle any recording made on the tape according to this International Standard.

### 3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

|                     |                                                                                                                                      |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| ISO 1001:1986       | <i>Information processing — File structure and labelling of magnetic tapes for information interchange</i>                           |
| ISO 527 (all parts) | <i>Plastics — Determination of tensile properties</i>                                                                                |
| ISO 3574:1999       | <i>Cold-reduced carbon steel sheet of commercial and drawing qualities</i>                                                           |
| ISO 4287:1997       | <i>Geometrical product specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters</i> |
| ISO/IEC 646:1991    | <i>Information technology — ISO 7-bit coded character set for information interchange</i>                                            |

|                      |                                                                                                                                              |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| ISO/IEC 11576:1994   | <i>Information technology — Procedure for the registration of algorithms for the lossless compression of data</i>                            |
| ISO/IEC 14443-2:2001 | <i>Identification cards — Contactless integrated circuit(s) cards — Proximity cards — Part 2: Radio frequency power and signal interface</i> |
| ISO/IEC 22091:2002   | <i>Information technology — Streaming Lossless Data Compression algorithm (SLDC)</i>                                                         |
| IEC 60950-1:2001     | <i>Information technology equipment — Safety — Part 1: General requirements</i>                                                              |
| ASTM D4065-01:1995   | <i>Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures</i>                                 |
| ASTM D4092-01:1996   | <i>Standard Terminology: Plastics: Dynamic Mechanical Properties</i>                                                                         |

## 4 Terms and definitions

For the purpose of this International Standard the following terms and definitions apply.

### 4.1 Access Point

A point, at the start of a sequence of Processed Records, at which the presentation of Symbols to a reprocessing algorithm is required to start at a known state to enable recovery, regardless of whether the data of interest in a retrieval operation starts at that point or at a subsequent point.

### 4.2 algorithm

A set of rules for transforming the logical representation of data.

### 4.3 algorithmically processed data

Data that has been processed by a defined processing algorithm.

### 4.4 a.c. erase

A process of erasure utilising alternating fields of decaying level.

### 4.5 Average Signal Amplitude

The average peak-to-peak value of the output signal from the read head at the fundamental frequency of the specified physical recording density over a minimum of 25,4 mm of track, exclusive of missing pulses.

### 4.6 back surface

The surface of the tape opposite to the magnetic coating which is used to record data.

### 4.7 Beginning of Tape (BOT)

The reference point on the tape nearest to the leader pin assembly.

### 4.8 Beginning of Wrap (BOW)

The Logical Point that indicates the beginning of a wrap: LP3 for forward wraps, LP4 for reverse wraps.

### 4.9 bit

A single digit in the binary number system, a ZERO or a ONE.

### 4.10 bit cell

A distance along the track between adjacent RLL encoded bits.

### 4.11 Broad Band Signal-to-Noise Ratio (BBSNR)

The average read signal power divided by the average integrated broad band (floor) RMS noise power and expressed in dB.

### 4.12 byte

An ordered set of eight bits (12 Channel bits) that are acted on as a unit.

### 4.13 cartridge

A case holding a single supply reel of magnetic tape and leader tape with an attached leader pin assembly at the BOT end.

**4.14 Channel bit**

A bit output from RLL channel encoding.

**4.15 Codeword**

A set of bytes containing data and the ECC bytes calculated on that data.

**4.16 Codeword Pair**

An interleaved pair of Codewords.

**4.17 Codeword Quad (CQ)**

A set of two Codeword Pairs.

**4.18 CQ Set**

A group of CQs that are written at the same time, i.e. one on each of the active tracks.

**4.19 cyclic redundancy check (CRC) character**

A mathematically computed code which yields check bytes used for the detection of errors.

**4.20 Data Set**

The smallest complete unit of information written to, or received from, the tape.

**4.21 Data Set Information Table (DSIT)**

A table within a Data Set which describes the content of the Data Set.

**4.22 End of Data (EOD)**

The point on the tape at the end of the last valid Data Set recorded on tape.

**4.23 End of Tape (EOT)**

The point on a track farthest from BOT up to which recording is allowed.

**4.24 End of Wrap (EOW)**

The Logical Point that indicates the end of a wrap: LP4 for forward wraps, LP3 for reverse wraps.

**4.25 Error Correcting Code (ECC)**

A mathematically computed code which yields check bytes used for the detection and correction of errors.

**4.26 File Mark**

A recorded element requested to be written (or read) by the host that is typically used to mark organisational boundaries in a serial file structure, such as directory boundaries.

**4.27 flux transition position**

The point on the magnetic tape that exhibits the maximum free-space flux density normal to the tape surface.

**4.28 flux transition spacing**

The distance along a track between successive flux transitions.

**4.29 forward tape motion**

The tape is moving forward when it is leaving the reel in the cartridge and being wound onto the reel in the mechanism.

**4.30 header**

Data that is prefixed to a data entity to provide identification and checking.

**4.31 Housekeeping Data Set**

A Data Set which contains no user data and which is identified as such by the values in the data fields therein.

#### **4.32 logical forward**

The direction of tape motion toward End of Wrap.

#### **4.33 logical reverse**

The direction of tape motion away from End of Wrap.

#### **4.34 Logical Point**

Defined bound where regions of the tape begin or end.

#### **4.35 magnetic tape**

A tape that accepts and retains magnetic signals intended for input, output, and storage of data for information processing.

#### **4.36 Master Standard Reference Tape (MSRT)**

A tape selected as the standard for reference recording current, signal amplitude, resolution, BBSNR, overwrite ratio, servo signal amplitude, and servo signal polarity.

NOTE - A Master Standard Reference Tape has been established at Ladas and Parry.

#### **4.37 LTO Cartridge Memory (LTO CM)**

A contactless storage device that is mounted in the case, and which can be used to hold information about that specific cartridge, the tape in the cartridge, and the data on the tape.

#### **4.38 Optimum Recording Current**

1,15 times the minimum current which, when applied to a magnetic tape, will cause the average signal amplitude to equal 95 % of the maximum average signal amplitude when recorded at density TRD1.

#### **4.39 physical end of tape**

Position of the tape farthest from the leader pin assembly at which the tape is cut and wrapped onto the hub during manufacture.

#### **4.40 physical forward**

The direction of tape motion from BOT to EOT. This will be logical forward for even numbered wraps.

#### **4.41 physical reverse**

The direction of tape motion from EOT to BOT. This will be logical forward for odd numbered wraps.

#### **4.42 pre-record condition**

A tape cartridge that has been a.c. erased and subsequently servo-written in preparation for data recording is in a pre-record condition.

#### **4.43 processed data**

A sequence of Symbols which results from the application of processing to data.

Data that has been processed by an algorithm.

#### **4.44 Processed Record**

A sequence of Symbols which results from the application of processing to a Protected Record.

#### **4.45 Processing (Compression)**

The use of an algorithm to transform host data into Symbols.

#### **4.46 Protected Record**

A Record with a 4-byte CRC added to the end. The CRC is checked during the deformatting process to ensure that the Record is uncorrupted.

**4.47 Record**

A Record is the smallest distinct set of data bytes supplied, e.g. from a host, for processing and recording by a tape drive system, and the smallest distinct set of data to be read from tape, reprocessed and made available, e.g. to a host, by a tape drive system.

**4.48 recorded element**

A File Mark or Record.

**4.49 Reference Recording Current**

The Optimum Recording Current of the Master Standard Reference Tape.

**4.50 Reprocessing (Decompression)**

The use of an algorithm to transform Symbols into data as required by the host.

**4.51 reverse tape motion**

The tape is moving in reverse when it is leaving the reel in the mechanism and being wound onto the reel in the cartridge.

**4.52 run length limited encoding (RLL)**

An algorithmic process applied to an arbitrary input binary sequence that produces an output binary sequence that has a specified minimum number of ZEROs between ONES, and a specified maximum number of ZEROs between ONES.

**4.53 Secondary Standard Reference Tape (SSRT)**

A tape, the performance of which is known and stated in relation to that of the Master Standard Reference Tape.

NOTE - Secondary Standard Reference Tapes can be ordered as "Ultrium Format Specification Generation 1 SSRT" from Ladas and Parry, 5670 Wilshire Blvd., 21st Floor, Los Angeles, CA 90036. In principle such tapes will be available for a period of 10 years from the publication of the first edition of this International Standard. However, by agreement between ECMA and Ladas and Parry, this period may be shortened or extended to take account of demands for such SSRTs.

It is intended that these SSRTs be used for calibrating tertiary reference tapes for use in routine calibration.

**4.54 servo acquisition region**

A region on tape that may be used by the servo circuitry.

**4.55 Standard Reference Amplitude (SRA)**

The average signal amplitude from the Master Standard Reference Tape when it is recorded with the Reference Recording Current at density TRD1. Traceability to the Standard Reference Amplitude is provided by the calibration factors supplied with each Secondary Standard Reference Tape.

**4.56 Symbol**

An associated string of bits generated by a processing (compression) algorithm, which represents a byte of data, a string of bytes of data, or control information.

**4.57 Synchronised Codeword Quad (SCQ)**

A serial bit stream formed by inserting synchronisation patterns into an RLL encoded Codeword Quad.

**4.58 Test Recording Density (TRD)**

The recording density at which specific tests are performed. There are three test recording densities: TRD1, TRD2 and TRD3. See 12.1.

**4.59 wrap**

A track group recorded in the physical forward or physical reverse direction.

**4.60 write equalisation**

An algorithmic process that linearly transforms an input binary sequence into another binary sequence.

**4.61 (1,7) RLL code**

A run length limited encoding scheme the output of which has no fewer than one ZERO between ONES and no more than seven ZEROs between ONES.

## 5 Conventions and notations

### 5.1 Representation of numbers

The following conventions and notations apply in this International Standard unless otherwise stated.

- A measured value is rounded off to the least significant digit of the corresponding specified value. It implies that a specified value of 1,26 with a positive tolerance +0,01, and a negative tolerance -0,02 allows a range of measured values from 1,235 to 1,275.
- In each block and in each field the bytes shall be arranged with Byte 0, the most significant, first. Within each byte the bits shall be arranged with Bit 7, the most significant, first and Bit 0, the least significant bit, last.
- Letters and digits in parentheses represent numbers in hexadecimal notation.
- The setting of bits is denoted by ZERO or ONE.
- Numbers in binary notation and bit patterns are represented by strings of digits 0 and 1 shown with the most significant bit to the left. Within such strings, X may be used to indicate that the setting of a bit is not specified within the string.

### 5.2 Dimensions

Unless otherwise stated, all dimensions in the figures are in millimetres with a tolerance of  $\pm 0,50$  mm.

### 5.3 Names

The names of basic elements, e.g. specific fields, are written with a capital initial letter.

### 5.4 Alphanumeric string encoding

Unless otherwise stated, all alphanumeric strings shall be encoded using ISO/IEC 646.

## 6 Acronyms

|       |                                   |
|-------|-----------------------------------|
| ACN   | Absolute CQ Sequence Number       |
| BOT   | Beginning of Tape                 |
| BBSNR | Broad Band Signal-to-Noise Ratio  |
| BOW   | Beginning of Wrap mark            |
| CRC   | Cyclic Redundancy Check character |
| DSIT  | Data Set Information Table        |
| ECC   | Error-Correcting Code             |
| EOD   | End of Data                       |
| EOT   | End of Tape                       |
| EOW   | End of Wrap mark                  |
| FID   | Format Identification Data Set    |
| LPn   | Logical Point, where n = 0 to 7   |
| LPOS  | Longitudinal Position             |
| lsb   | Least Significant Bit             |
| LSB   | Least Significant Byte            |
| msb   | Most Significant Bit              |
| MSB   | Most Significant Byte             |
| MSRT  | Master Standard Reference Tape    |
| RLL   | Run Length Limited                |
| RWW   | Read-While-Write                  |
| SCQ   | Synchronised Codeword Quad        |
| SNR   | Signal-to-Noise Ratio             |
| SRA   | Standard Reference Amplitude      |
| SSRT  | Secondary Standard Reference Tape |
| TRD   | Test Recording Density            |

## 7 Environment and safety

The conditions specified below refer to the ambient conditions immediately surrounding the cartridge.

### 7.1 Cartridge and tape testing environment

Unless otherwise stated, tests and measurements made on the cartridge and tape to check the requirements of this International Standard shall be carried out under the following conditions:

- temperature: 23 °C ± 2 °C
- relative humidity: 40 % to 60 %
- conditioning before testing: 24 h min.

### 7.2 Cartridge operating environment

Cartridges used for data interchange shall be capable of operating under the following conditions:

- temperature: 10 °C to 45 °C
- relative humidity: 10 % to 80 %
- wet bulb temperature: 26 °C max.

NOTE - Local tape temperature in excess of 52 °C may cause permanent tape damage.

If during storage and/or transportation a cartridge has been exposed to conditions outside the above values, it shall be conditioned before use by exposure to the operating environment for a time equal to, or greater than, the time away from the operating environment up to a maximum of 24 h. There shall be no deposit of moisture on or in the cartridge.

### 7.3 Cartridge storage environment

Cartridges shall be stored under the following conditions:

- temperature: 16 °C to 32 °C
- relative humidity: 20 % to 80 %
- wet bulb temperature: 26 °C max.

The stray magnetic field at any point on the tape shall not exceed 4 000 A/m. There shall be no deposit of moisture on or in the cartridge.

### 7.4 Tape tension

The tape between LP1 and LP6 shall not be subjected to a tension higher than 2,0 N under any circumstance. Outside of this area the tape shall not be subjected to a tension higher than 6,0 N.

### 7.5 Safety

The cartridge and its components shall satisfy the requirements of IEC 60950-1 when used in the intended manner or in any foreseeable use in an information processing system.

### 7.6 Flammability

The cartridge as an assembly shall be constructed such that, if ignited from a match flame, and when so ignited does not continue to burn in a still carbon dioxide atmosphere.

### 7.7 Transportation

Recommended limits for the environments to which a cartridge may be subjected during transportation, and the precautions to be taken to minimise the possibility of damage, are provided in annex G.

## Section 2 - Requirements for the Cartridge

### 8 Dimensional and Mechanical Characteristics of the Cartridge

#### 8.1 Elements of the cartridge

The tape cartridge shall consist of the following elements:

- a case
- positioning notches
- handling notches
- a write-inhibit mechanism
- a reel for magnetic tape
- a locking mechanism for the reel
- a magnetic tape wound on the hub of the reel
- a leader pin
- a parking mechanism for the leader pin
- a sliding door
- a cartridge memory
- handling features

Dimensional characteristics are specified for those parameters deemed mandatory for interchange and compatible use of the cartridge. Where there is freedom of design, only the functional characteristics of the elements described are indicated. In the figures a typical implementation is represented in third angle projection.

Figure 1 : General view of the cartridge

Figure 2 : View of the Reference Planes A, B and C

Figure 3 : Bottom side

Figure 4 : Top side

Figure 5 : Rear side

Figure 6 : Front side

Figure 7 : Right side

Figure 8 : Left side with access door open

Figure 9 : Locking pad features in the reel

Figure 10 : Cross-section of the hub/brake assembly in the in-hand position

Figure 11 : Enlarged partial view from figure 10

Figure 12 : Cross-section of the hub/brake assembly in the cartridge-in-drive position

Figure 13 : Cross-section as viewed toward centre of reel through the teeth at diameter 37,50 mm

Figure 14 : Cross-section of a tooth part

Figure 15 : Leader pin assembly with attached tape seen from the top and from the side

Figure 16 : Leader pin assembly in parked position and detail of the door in closed position

Figure 17 : Leader pin assembly in parked position and door in open position, viewed from the left side

Figure 18 : Location of the LTO CM

Figure 19 : Handling grips and cartridge insertion indicator

#### 8.2 Reference Planes of the case (figure 2)

Where they are purely descriptive, the dimensions are referred to three orthogonal reference planes – A, B, and C. Where the dimensions are related to the position of the cartridge in the drive, they may be referenced to Plane P.

Three locating areas  $A_1$ ,  $A_2$ , and  $A_3$  shall be in Plane A. Plane B is perpendicular to Plane A and passes through the centre of locating hole  $B_1$  and the centreline of locating slot  $B_2$ . Plane C is perpendicular to Planes A and B and passes through the centre of locating hole  $B_1$ .

#### 8.3 Dimensions of the case

The dimensions of the case shall be measured in the Test Environment. The dimensions of the case in any operating environment can be derived from the dimensions specified in this clause.

##### 8.3.1 Overall dimension (figures 4, 6, 8)

The length of the case shall be

$$l_1 = 102,00 \text{ mm} \pm 0,30 \text{ mm}$$

The width of the case shall be

$$l_2 = 105,40 \text{ mm} \pm 0,30 \text{ mm}$$

The height of the case shall be

$$l_3 = 21,50 \text{ mm} \pm 0,25 \text{ mm}$$

The height of the stacking features is not included in  $l_3$ .

The case shall have general radii for vertical edges and horizontal edges.

The radius of the specified vertical edges shall be

$$r_1 = 2,00 \text{ mm} \pm 0,50 \text{ mm}$$

The radius of the specified horizontal edges shall be

$$r_2 = 1,00 \text{ mm} \pm 0,50 \text{ mm}$$

All other features shall have general radii of 0,50 mm max.

### 8.3.2 Reference points for reference planes (figure 3)

The locating areas  $A_1$ ,  $A_2$ , and  $A_3$  shall be flush with the bottom of the cartridge. The locating area  $A_4$  shall be within 0,25 mm from Plane A in the free state. These locating areas shall be non-textured to allow accurate locating of the cartridge on reference points in the mechanism and handling equipment.

The size and location of the four locating areas,  $A_1$ ,  $A_2$ ,  $A_3$ , and  $A_4$  (see figure 3), are specified as follows.

The centre of locating area  $A_1$  is on the intersection of Planes B and C, thus its position is specified by

$$l_4 = 20,50 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_5 = 11,45 \text{ mm} \pm 0,20 \text{ mm}$$

Its diameter shall be

$$d_1 = 7,80 \text{ mm min.}$$

The locating area  $A_2$  presents an oval area. The length shall be

$$l_6 = 1,80 \text{ mm min.}$$

The radius at the end of the oval shall be

$$r_3 = 3,80 \text{ mm min.}$$

The centre of locating area  $A_2$  is on Plane B at a distance

$$l_7 = 86,15 \text{ mm} \pm 0,25 \text{ mm}$$

from Plane C.

The position of the rectangular locating area  $A_3$  shall be

$$l_8 = 13,75 \text{ mm min.}$$

$$l_9 = 4,75 \text{ mm min.}$$

The position of the rectangular locating area  $A_4$  shall be

$$l_{10} = 13,75 \text{ mm min.}$$

$$l_{11} = 4,75 \text{ mm min.}$$

The position of the locating features  $B_1$  and  $B_2$  for Plane B shall be specified as follows.

$B_1$  shall be centred within locating area  $A_1$ . It shall be a square hole of side

$$l_{12} = 3,00 \text{ mm} \pm 0,08 \text{ mm}$$

with rounded corners with a maximum radius of 1,00 mm.

$B_2$  shall be centred within location area  $A_2$ . It shall be a slot of side

$$l_{12} = 3,00 \text{ mm} \pm 0,08 \text{ mm}$$

Both  $B_1$  and  $B_2$  shall have a depth specified by

$$l_{13} = 5,00 \text{ mm min.}$$

### 8.3.3 Positioning notches (figures 3, 6, 7)

There shall be three positioning notches, open toward the bottom side, and one secondary datum area on the front of the cartridge. Where surfaces have draft angle, dimensions shall be controlled at Plane A (except as noted), and the angle shall be  $0^\circ 45'$  nominal.

The location of the centre of the V-shaped notch shall be specified by

$$l_{14} = 81,95 \text{ mm} \pm 0,15 \text{ mm}$$

$$l_{15} = 15,47 \text{ mm} \pm 0,15 \text{ mm}$$

Its radius at the bottom shall be

$$r_4 = 1,50 \text{ mm max.}$$

Its opening shall be

$$\alpha_1 = 60^\circ \pm 1^\circ$$

The depth of the V-shaped notch shall be

$$l_{16} = 8,90 \text{ mm min.}$$

This notch position is measured with a 3,50 mm spherical probe, 3,0 mm above Plane A.

The dimensions of the two side notches shall be specified as follows.

Their dimension shall be

$$l_{17} = 47,50 \text{ mm} \pm 0,15 \text{ mm}$$

The length of the notches shall be

$$l_{18} = 5,00 \text{ mm} \pm 0,15 \text{ mm}$$

The width of the notches shall be

$$l_{19} = 2,80 \text{ mm min.}$$

The depth of the notches shall be

$$l_{20} = 8,70 \text{ mm min.}$$

The secondary datum area on the front of the cartridge shall be specified by

$$l_{300} = 8,00 \text{ mm min.}$$

$$l_{301} = 7,50 \text{ mm max.}$$

$$l_{302} = 13,50 \text{ mm min.}$$

This surface may have draft from Plane A and shall be located at a distance from Plane B by

$$l_{303} = 20,36 \text{ mm} \pm 0,10 \text{ mm}$$

when measured with a spherical probe, 3,0 mm above Plane A.

### 8.3.4 Handling notches (figures 3, 4, 7)

There shall be three notches used for handling. They shall be specified as follows:

The dimensions of the bottom notches shall be

$$l_{21} = 81,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{22} = 82,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{23} = 6,00 \text{ mm} \pm 0,25 \text{ mm}$$

The width of the bottom notches shall be

$$l_9 = 4,75 \text{ mm min.}$$

The depth of the bottom notches shall be

$$l_{20} = 8,70 \text{ mm min.}$$

The dimensions of the side notch shall be

$$l_{24} = 6,00 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{25} = 18,00 \text{ mm} \pm 0,50 \text{ mm}$$

$$\alpha_2 = 30^\circ \pm 2^\circ$$

$$\alpha_3 = 60^\circ \pm 2^\circ$$

$$l_{26} = 2,25 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{27} = 10,75 \text{ mm} \pm 0,50 \text{ mm}$$

### 8.3.5 Mis-insertion protection (figures 4, 6)

The cartridge shall have a cut-out in the front side of the case to prevent the cartridge from being inserted into the drive in the wrong orientation. This feature further prevents the use of unsuitable cartridges of similar, but not identical, construction.

The depth of the notch shall be

$$l_{28} = 5,00 \text{ mm} \pm 0,25 \text{ mm}$$

The surface it forms shall be defined by  $l_{29} = 16,80 \text{ mm}$  nominal and the tangent to an arc  $r_5 = 51,50 \text{ mm}$  nominal with the same centre as the central window as described in 8.3.8. The actual surface shall be within 0,50 mm of this nominal geometry.

### 8.3.6 Stacking features (figures 3, 4, 5, 8)

The bottom side of the case shall have four parallel stacking ribs. The dimensions shall be

$$l_{30} = 3,00 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{31} = 67,45 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{32} = 6,00 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{108} = 1,20 \text{ mm max.}$$

$$l_{200} = 50,00 \text{ mm} \pm 0,30 \text{ mm}$$

The corners shall have a radius

$$r_6 = 0,60 \text{ mm min.}$$

The height shall be defined by

$$l_{33} = 0,50 \text{ mm} \pm 0,15 \text{ mm (measured locally around each pad)}$$

The top side of the case shall have recess areas for the stacking ribs to fit into. The dimensions shall be

$$l_{34} = 67,45 \text{ mm} \pm 0,30 \text{ mm}$$

$$l_{35} = 6,60 \text{ mm} \pm 0,30 \text{ mm}$$

$$l_{36} = 4,30 \text{ mm} \pm 0,30 \text{ mm}$$

$$l_{201} = 50,00 \text{ mm} \pm 0,30 \text{ mm}$$

The depth of the recess areas shall be

$$l_{37} = 0,85 \text{ mm min. (measured locally around each recess)}$$

The radii of the recess areas shall be

$$r_7 = 0,35 \text{ mm max.}$$

### 8.3.7 Label area of the rear side (figure 5)

There shall be one label area on the rear side of the case.

The distance of the bottom edge of the label area from the bottom side of the case shall be

$$l_{38} = 2,00 \text{ mm} \pm 0,25 \text{ mm}$$

It shall be recessed from the rear side by 0,20 mm min. and 0,50 mm max.

The radii of the corners shall be

$$r_8 = 1,25 \text{ mm max.}$$

The distance of the edge of the label area from the left side of the case shall be

$$l_{40} = 7,50 \text{ mm} \pm 0,25 \text{ mm}$$

The width of the label area shall be

$$l_{41} = 80,00 \text{ mm} \pm 0,35 \text{ mm}$$

The top of the label area shall be

$$l_{42} = 19,50 \text{ mm} \pm 0,35 \text{ mm}$$

### 8.3.8 Central window (figure 3)

The bottom side of the case shall have a central window to allow penetration of the drive spindle into the hub.

Its diameter shall be

$$d_3 = 40,00 \text{ mm min.}$$

Its centre shall be defined by

$$l_{43} = 42,45 \text{ mm} \pm 0,15 \text{ mm}$$

$$l_{44} = 30,50 \text{ mm} \pm 0,15 \text{ mm}$$

### 8.3.9 Sliding door (figures 8, 16)

On the left side of the cartridge, there shall be a door that slides toward the rear of the cartridge when opened. This door shall be held in place by features internal to the case. The force required to slide the door fully open shall be no greater than 1,30 N at  $l_{50}$  dimension. The cartridge means to close the door shall provide a minimum of 0,20 N closing force at the fully closed position.

The door shall have a feature for opening as detailed with the following dimensions

$$l_{250} = 10,00 \text{ mm min.}$$

$$r_9 = 0,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{46} = 0,75 \text{ mm max. (no protrusion beyond cartridge case)}$$

$$l_{47} = 0,60 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{48} = 2,95 \text{ mm min.}$$

The door shall provide protection on one side of the cartridge and when in the open position, the door shall provide the opening as outlined in 8.3.10.

### 8.3.10 Case opening (figures 8, 16)

The case shall have an opening that is visible when the door is in the open position. This opening is where the leader pin assembly is seated.

The opening shall be defined by

$$l_{45} = 12,50 \text{ mm} \pm 0,25 \text{ mm (located with respect to the centreline shown)}$$

$$l_{49} = 17,20 \text{ mm min.}$$

$$l_{50} = 4,00 \text{ mm min.}$$

$$r_{10} = 2,50 \text{ mm max.}$$

$$r_{11} = 1,00 \text{ mm} \pm 0,25 \text{ mm}$$

## 8.4 Write-inhibit mechanism (figures 3, 5)

The write-inhibit mechanism shall have a flat surface identified by a visual lock mark, such as a padlock on the rear of the cartridge, when in the position in which writing is inhibited. In the write-enabled position the surface of the write-inhibit mechanism shall be flush to 0,30 mm from the bottom surface of the cartridge case. In the write-inhibit position the write-inhibit mechanism shall be at a minimum distance of 5,00 mm from the bottom surface. The force needed to move the write-inhibit assembly, when applied tangentially to the surface of the cartridge, shall be in the range 2 N to 7 N.

The target area for sensing on the bottom of the case shall be

$$l_{51} = 77,50 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{52} = 82,95 \text{ mm} \pm 0,20 \text{ mm}$$

The sensing area on the bottom of the case shall be defined by

$$d_4 = 4,00 \text{ mm min.}$$

The write-inhibit indication window on the rear side of the case shall be defined by

$$l_{53} = 7,50 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{54} = 14,50 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{55} = 5,75 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{56} = 15,75 \text{ mm} \pm 0,50 \text{ mm}$$

## 8.5 Flexibility of the case

The flexibility of the top and bottom sides of the case of the assembled cartridge (see figure 4) is the amount of deflection observed when they are subjected to a perpendicular force, with the cartridge resting on a flat surface.

### 8.5.1 Requirements

The case shall not deflect by more than 2,50 mm max. when a force of 35,0 N is applied as described in 8.5.2.

### 8.5.2 Procedure

Measure the flexibility of the case in a universal testing machine operating in compression mode, using a suitable load cell for the test.

Apply a single point load with a radius of 10 mm  $\pm$  1 mm to the top side of the case at the point shown in figure 4 and specified by

$$l_{57} = 53,90 \text{ mm nominal}$$

$$l_{58} = 76,00 \text{ mm nominal}$$

Repeat for the bottom side at the same point and specified by the same method.

## 8.6 Tape reel

### 8.6.1 Locking mechanism (figure 9)

The locking mechanism for the tape reel maintains pack tension during shipping and storage over the allowable range of environmental conditions. Functionally, it shall satisfy the following requirements in the locked position:

- the angular resolution shall not be greater than 3°
- the reel shall not rotate by more than 10° when a torque not greater than 0,32 N·m is applied in the direction that will cause the tape to unwind

The locking mechanism shall have an interface to the drive through 3 pads protruding through the toothed rim. The dimensions of the locking pads shall be

$$r_{12} = 17,50 \text{ mm nominal}$$

$$l_{59} = 1,00 \text{ mm min.}$$

$$l_{60} = 3,00 \text{ mm min.}$$

and no larger than the space from removal of 2 or 3 teeth of the toothed rim per locking pad. The locking pads shall be centred on the mating tooth (for 2 teeth removed) or teeth (for 3 teeth removed). The angle between the locking pads shall be

$$\alpha_5 = 120,00^\circ \text{ nominal}$$

These pads shall be flush within 0,10 mm with the flats on the toothed rim in the locked or in hand position. With the cartridge in the drive, the pads shall be recessed  $1,80 \text{ mm} \pm 0,15 \text{ mm}$  from the flats on the toothed rim. The ends of the locking pads shall have no sharp corners, edges, or burrs. The force required to move the three locking pads into this position shall be greater than 2,80 N at the in-hand position and not exceed 5,00 N at the in-drive position. The 3 pads protruding through the toothed rim shall be non-metallic.

#### 8.6.2 Axis of rotation of the reel (figure 3)

The axis of rotation of the reel shall be perpendicular to Plane P and pass through the centre of the central window as specified by  $l_{43}$  and  $l_{44}$ .

#### 8.6.3 Reel flanges (figure 12)

The outside diameter of the reel flanges shall be

$$d_5 = 96,80 \text{ mm min.}$$

There shall be a radius on the tape side of the flanges at the outside diameter

$$r_{200} = 0,50 \text{ mm} \pm 0,25 \text{ mm}$$

The distance from the inside of the lower flange of the reel to Plane P shall be

$$l_{66} = 1,92 \text{ mm} \pm 0,10 \text{ mm at the hub diameter } d_9$$

The distance from the inside of the upper flange of the reel at the hub diameter  $d_9$  to Plane P shall be

$$l_{62} = 14,88 \text{ mm} \pm 0,10 \text{ mm at the hub diameter } d_9$$

The distance from the inside of the lower flange of the reel at the flange outer diameter  $d_5$  shall be

$$l_{63} = 1,78 \text{ mm} \pm 0,12 \text{ mm at the flange outer diameter } d_5$$

The distance from the inside of the upper flange of the reel at the flange outer diameter  $d_5$  shall be

$$l_{600} = 15,02 \text{ mm} \pm 0,12 \text{ mm at the flange outer diameter } d_5$$

The maximum lower flange total indicated runout shall be 0,165 mm for any diameter along the tapered surface. The maximum upper flange total indicated runout shall be 0,165 mm for any diameter along the tapered surface.

There shall be a minimum taper of 0,03 mm on both upper and lower flanges with no negative taper areas on the surface. Taper is defined by the difference between the minimum height of the flange at the inner diameter circumference and the maximum height of the flange at the outer diameter circumference, both measured relative to the Plane P for the bottom flange.

The minimum hub height (flange to flange spacing) at the diameter  $d_9$  shall be 12,78 mm.

The radius at the intersection of the flanges and the outer surface of the hub shall be

$$r_{13} = 0,08 \text{ mm max.}$$

#### 8.6.4 Metallic insert (figures 9, 11, 12)

The reel shall have a metallic insert made of low carbon steel (AISI 1005 through 1095), with nickel plating to prevent corrosion.

The thickness shall be

$$l_{61} = 1,00 \text{ mm} \pm 0,06 \text{ mm}$$

The outer diameter shall be

$$d_6 = 30,00 \text{ mm} \pm 0,25 \text{ mm}$$

The inner diameter shall be

$$d_7 = 9,00 \text{ mm} \pm 0,25 \text{ mm}$$

and shall be concentric with the axis of rotation within 0,20 mm.

The metallic insert shall be parallel to Plane P within 0,15 mm.

It shall withstand a pull out force of 150 N min.

If holes are used in the insert to improve pull-out retention between the insert and molded reel, they shall not exceed 10,0 mm<sup>2</sup> total area.

#### 8.6.5 Toothed rim (figures 9, 12, 14)

The reel shall have a toothed rim accessible through the central window. Its dimensions shall be

$$d_{16} = 30,50 \text{ mm} \pm 0,75 \text{ mm}$$

$$d_8 = 40,00 \text{ mm} \pm 0,25 \text{ mm}$$

#### 8.6.6 Hub of the reel (figure 12)

The diameter of the hub shall be

$$d_9 = 44,00 \text{ mm} \pm 0,10 \text{ mm}$$

The hub shall meet the following requirements:

- the straightness of the hub surface shall be within 0,04 mm
- the perpendicularity to Plane P (see 8.6.8 for Plane P definition) shall be within 0,07 mm
- conical taper shall not exceed 0,4 %
- the rate of change of diameter  $d_9$  across the width of the hub surface shall not exceed 0,025 mm per mm
- the total runout of the hub relative to the cylinder perpendicular to the circular pitch line of the teeth of the toothed rim shall not exceed 0,10 mm total indicator reading (TIR)

#### 8.6.7 Relative positions of hub and case (figures 3, 9, 10, 11, 12)

With the cartridge held in the hand

The distance from the surface of the flats of the toothed rim to Plane A shall be

$$l_{64} = 0,25 \text{ mm} \pm 0,25 \text{ mm}$$

The  $d_{16}$  dimension of the reel shall be centred to the central window  $d_3$  (figure 3) within 0,25 mm in the bottom or horizontal orientation and within 0,30 mm in the vertical orientation (resting on right or left side).

With the cartridge in the hand or in the drive

The distance from the bottom surface of the metallic insert to Plane P shall be

$$l_{65} = 1,40 \text{ mm} \pm 0,10 \text{ mm}$$

With the cartridge in the drive

The distance from the tips of the three locking pads to Plane A shall be

$$l_{67} = 3,25 \text{ mm} \pm 0,25 \text{ mm}$$

The distance from Plane A to Plane P shall be

$$l_{69} = 2,35 \text{ mm} \pm 0,15 \text{ mm}$$

A minimum clearance of 0,50 mm shall be maintained between the reel and the inside surfaces of the case for all tolerance conditions and feature sizes.

#### 8.6.8 Characteristics of the toothed rim (figures 9, 13, 14)

The toothed rim shall contain no fewer than 42 teeth, spaced at an angle of

$$\alpha_6 = 6^\circ \pm 10' \text{ non-cumulative}$$

If fewer than 54 teeth (60 minus 3 sets of 2 for the locking pads) are provided, the teeth shall be grouped into 6 contiguous groups, symmetrically arranged adjacent to the locking pads with no gaps greater than 3 teeth.

The teeth are specified at the pitch diameter 37,50 mm.

The theoretical tip to tip dimension shall be

$$l_{70} = 2,321\ 4\ \text{mm}$$

Plane P is a plane defined by the pitch line of the hub teeth at the 37,50 mm diameter.

Plane P shall be defined at the distance  $l_{71} = 1,160\ 7\ \text{mm}$  or halfway between the theoretical tips of a complete tooth.

The angle of the teeth shall be defined by

$$\alpha_7 = 30^\circ\ \text{nominal}$$

$$\alpha_8 = 15^\circ\ \text{nominal}$$

the error of the tooth angle  $\alpha_7$  and  $\alpha_8$  shall be less than or equal to  $10'$  (non-cumulative).

The pitch line shall be the circumference of the teeth in Plane P.

The flat at the tips of the teeth shall be defined by

$$l_{72} = 0,90\ \text{mm} \pm 0,05\ \text{mm}$$

The trough at the bottom of the tooth shall be defined by

$$l_{73} = 1,16\ \text{mm min. centre of radius}$$

$$l_{74} = 0,50\ \text{mm} \pm 0,20\ \text{mm}$$

The geometry of the toothed rim around the outside diameter (figure 14) shall be

$$d_{10} = 37,85\ \text{mm min.}$$

$$d_{11} = 39,00\ \text{mm} \pm 0,15\ \text{mm}$$

$$\alpha_9 = 45^\circ \pm 5^\circ$$

## 8.7 Magnetic tape

### 8.7.1 Tape wind

When the cartridge is viewed from the top side, turning the hub counter-clockwise shall wind tape onto the hub, with the recording surface toward the outside (away from the hub).

The end of the tape shall not be attached to the hub.

### 8.7.2 Wind tension

The tape shall be wound with a tension of  $1,00\ \text{N} \pm 0,40\ \text{N}$ .

### 8.7.3 Circumference of the tape reel

For the following lengths of tape (see 9.2), the circumference of a wound tape shall be

Type A            295,33 mm nominal

Type B            234,06 mm nominal

Type C            204,48 mm nominal

Type D            169,82 mm nominal

### 8.7.4 Moment of inertia

The moment of inertia of the reel and tape shall be

For the empty reel         $28,40 \times 10^{-6}\ \text{kg}\cdot\text{m}^2 \pm 2,84 \times 10^{-6}\ \text{kg}\cdot\text{m}^2$

For Type A                 $16,69 \times 10^{-5}\ \text{kg}\cdot\text{m}^2 \pm 1,67 \times 10^{-5}\ \text{kg}\cdot\text{m}^2$

For Type B                 $7,88 \times 10^{-5}\ \text{kg}\cdot\text{m}^2 \pm 0,78 \times 10^{-5}\ \text{kg}\cdot\text{m}^2$

For Type C                 $5,49 \times 10^{-5}\ \text{kg}\cdot\text{m}^2 \pm 0,55 \times 10^{-5}\ \text{kg}\cdot\text{m}^2$

For Type D                 $3,73 \times 10^{-5}\ \text{kg}\cdot\text{m}^2 \pm 0,37 \times 10^{-5}\ \text{kg}\cdot\text{m}^2$

#### 8.7.4.1 Procedure

Torsionally oscillate the reel on an inertial dynamics unit. Measure the period of oscillation with a universal counter. Convert the period of oscillation to its rotational value.

### 8.8 Leader pin assembly

#### 8.8.1 Leader pin assembly dimensions (figure 15)

The leader pin assembly shall have the following dimensions

$$l_{75} = 19,46 \text{ mm} \pm 0,04 \text{ mm}$$

$$l_{76} = 1,480 \text{ mm} \pm 0,075 \text{ mm}$$

$$l_{77} = 3,130 \text{ mm} \pm 0,075 \text{ mm}$$

$$d_{12} = 2,90 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{78} = 13,200 \text{ mm} \pm 0,075 \text{ mm}$$

$$l_{79} = 17,980 \text{ mm} \pm 0,075 \text{ mm}$$

$$d_{13} = 3,20 \text{ mm} \pm 0,05 \text{ mm}$$

$$d_{14} = 1,60 \text{ mm} \pm 0,05 \text{ mm}$$

$$r_{14} = 0,05 \text{ mm min.}$$

$$r_{15} = 14,75 \text{ mm} \pm 4,75 \text{ mm (no sharp points or cut-off nibs allowed)}$$

$$r_{16} = 0,20 \text{ mm} \pm 0,10 \text{ mm}$$

The leader pin assembly shall be made from non-magnetic materials with maximum magnetic level of 3 200 A/m.

#### 8.8.2 Leader tape attachment to leader pin assembly (figure 15)

The leader tape shall be attached to the leader pin assembly centred to  $l_{78}$  within 0,15 mm.

The leader tape shall be retained to the leader pin assembly by means that shall not protrude beyond  $d_{12}$ .

The bottom edge of the tape (as seen in figure 15) shall be perpendicular to the axis of the leader pin assembly (centre of  $d_{14}$ ) within 0,50 mm over the first 150,0 mm of tape.

The leader pin assembly shall not detach from the tape when a force of 16 N is applied normal to the pin assembly, over all operating environmental conditions (see 7.2).

If the leader pin assembly has a portion of diameter  $d_{12}$  open, the tape shall be wrapped around the central pin as shown in figure 15, so that the open section faces the front of the cartridge. The open section shall not be more than 120° of the cylinder and the free end of the tape shall not extend more than 1,50 mm beyond  $d_{12}$ .

#### 8.8.3 Latching the leader pin assembly in the case (figures 16, 17)

This International Standard does not specify the implementation of the latching mechanism for the leader pin assembly. This International Standard specifies the position of the leader pin assembly and the forces required to pull it out of the cartridge and to insert it into the cartridge.

When the leader pin assembly is latched into the case, the point shall be defined by

$$l_{80} = 13,50 \text{ mm nominal}$$

$$l_{81} = 6,30 \text{ mm nominal}$$

The leader pin assembly shall fall within a circle of radius 0,25 mm.

The leader pin assembly parking position relative to Plane A shall be

$$l_{82} = 1,00 \text{ mm} \pm 0,20 \text{ mm}$$

The leader pin assembly parking position shall have a lead-in defined by

$$\alpha_{10} = 20^\circ \pm 2^\circ$$

$$\alpha_{11} = 10^\circ \pm 2^\circ$$

$$l_{83} = 1,00 \text{ mm nominal}$$

$$l_{84} = 1,50 \text{ mm nominal}$$

$$l_{304} = 3,50 \text{ mm nominal}$$

and  $r_{17} = 0,20 \text{ mm min.}$  (no sharp edges or flash permitted)

$$l_{305} = 0,40 \text{ mm min.}$$

$$l_{306} = 0,90 \text{ mm min.}$$

This lead-in area shall have no sharp edges or flash and shall be recessed from the outside of the case by

$$l_{85} = 0,50 \text{ mm} \pm 0,20 \text{ mm}$$

The limits on the insertion force shall be met when the leader pin assembly is positioned within 0,60 mm toward the front of the cartridge, or 1,34 mm toward the rear of the cartridge from the nominal parking position as defined by  $l_{80}$  and  $l_{81}$ . The extraction and insertion force, i.e. the force required to pull (push) the leader pin assembly and the tape attached to it out of (into) the cartridge, shall be greater than 0,50 N and less than 1,50 N, measured perpendicular to the Plane of the door opening.

The retention means and/or geometry described above shall maintain the leader pin assembly position when a force of 6 N is applied to the leader pin assembly toward the right side of the cartridge, or at any angle up to

$$\alpha_{14} = 85^\circ$$

from the right side toward the front of the cartridge. See figure 16.

#### 8.8.4 Mechanism and tape exit keepout area (figure 16, 17)

The cartridge shall have volume clear of any components or material for access by the mechanism and tape travel. The total volume reserved for mechanism keepout and tape travel shall be defined by

$$l_{202} = 2,10 \text{ mm max.}$$

$$l_{203} = 4,40 \text{ mm min.}$$

$$l_{204} = 1,90 \text{ mm min.}$$

$$l_{205} = 3,00 \text{ mm max.}$$

$$l_{206} = 17,25 \text{ mm min.}$$

$$l_{207} = 18,00 \text{ mm min.}$$

$$l_{208} = 18,50 \text{ mm min.}$$

$$l_{209} = 7,45 \text{ mm min.}$$

$$l_{210} = 14,70 \text{ mm min. about the centreline of the cartridge}$$

$$l_{211} = 2,30 \text{ mm max.}$$

$$l_{212} = 19,10 \text{ mm min.}$$

#### 8.9 LTO CM (figure 18)

Figure 18 shows the general layout of the LTO CM, showing the top view of a case bottom half and left side (or leader pin assembly side) as described in figure 1. The dimensions of the device shall be

$$l_{86} = 20,00 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{87} = 10,00 \text{ mm} \pm 0,50 \text{ mm}$$

$$l_{88} = 0,80 \text{ mm} \pm 0,20 \text{ mm}$$

$$r_{18} = 2,50 \text{ mm} \pm 0,50 \text{ mm}$$

The location of the LTO CM in the case and the dimensions controlling its position shall be

$$l_{89} = 1,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{90} = 1,50 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{91} = 5,00 \text{ mm} \pm 0,30 \text{ mm}$$

$$\alpha_{12} = 45^\circ \pm 3^\circ$$

No metal components shall be closer than 2,00 mm to the LTO CM.

### 8.10 Areas reserved for cartridge presence sensing (figure 3)

The following areas shall have material present in Plane A, in order to allow mechanisms to sense that the cartridge is properly seated in the drive.

Location 1 shall be

$$l_{51} = 77,50 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{93} = 88,45 \text{ mm} \pm 0,20 \text{ mm}$$

$$d_{15} = 4,00 \text{ mm min.}$$

Location 2 shall be

$$l_{109} = 18,00 \text{ mm} \pm 0,20 \text{ mm}$$

$$l_{110} = 24,00 \text{ mm} \pm 0,20 \text{ mm}$$

$$d_{17} = 5,50 \text{ mm max. (within edge of cartridge)}$$

### 8.11 Handling grips and insertion indicator (figure 19)

There shall be features on the top, bottom and sides of the cartridge to provide a positive grip for manual handling of the cartridge, and an arrow indicating the proper insertion direction of the cartridge into a mechanism. These features shall be moulded into the respective surfaces, 0,30 mm  $\pm$  0,10 mm deep.

#### 8.11.1 Side grips

The grip feature on each side of the cartridge shall be described by

$$l_{94} = 1,20 \text{ mm} \pm 0,20 \text{ mm (6 places)}$$

$$l_{95} = 9,00 \text{ mm} \pm 0,25 \text{ mm}$$

$$l_{96} = 0,90 \text{ mm} \pm 0,20 \text{ mm (5 places)}$$

$$l_{97} = 2,50 \text{ mm} \pm 0,25 \text{ mm}$$

#### 8.11.2 Insertion indicator

The indicator for proper insertion direction shall be centred side to side on the top of the cartridge, and shall be defined by

$$l_{98} = 4,70 \text{ mm} \pm 0,30 \text{ mm}$$

$$\alpha_{13} = 86,0^\circ \pm 3,0^\circ$$

and an arc with centre and radius shall be defined by

$$l_{99} = 36,00 \text{ mm} \pm 0,40 \text{ mm}$$

$$l_{100} = 52,70 \text{ mm} \pm 0,40 \text{ mm (the centreline of the cartridge)}$$

$$r_{19} = 24,0 \text{ mm} \pm 0,40 \text{ mm}$$

#### 8.11.3 Top grip

The grip feature on the top of the cartridge shall be described by

$$l_{101} = 0,90 \text{ mm} \pm 0,20 \text{ mm (9 places)}$$

$$l_{102} = 1,20 \text{ mm} \pm 0,20 \text{ mm (10 places)}$$

$$r_{20} = 50,0 \text{ mm} \pm 0,40 \text{ mm}$$

$$r_{21} = 46,0 \text{ mm} \pm 0,40 \text{ mm}$$

$$r_{22} = 35,0 \text{ mm} \pm 0,40 \text{ mm (2 places)}$$

$$r_{23} = 39,0 \text{ mm} \pm 0,40 \text{ mm (2 places)}$$

$$r_{20} \text{ and } r_{21} \text{ are from the centre located by}$$

$$l_{103} = 25,00 \text{ mm} \pm 0,40 \text{ mm}$$

$$l_{100} = 52,70 \text{ mm} \pm 0,40 \text{ mm}$$

$r_{22}$  and  $r_{23}$  shall be from the centre located by

$$l_{104} = 39,00 \text{ mm} \pm 0,40 \text{ mm} \text{ and tangent to } r_{20} \text{ and } r_{21} \text{ respectively}$$

#### 8.11.4 Bottom grip

The grip feature on the bottom of the cartridge shall be described by

$$l_{105} = 1,20 \text{ mm} \pm 0,20 \text{ mm (6 places)}$$

$$l_{106} = 0,90 \text{ mm} \pm 0,20 \text{ mm (5 places)}$$

$$r_{24} = 18,0 \text{ mm} \pm 0,40 \text{ mm}$$

$$r_{25} = 13,0 \text{ mm} \pm 0,40 \text{ mm}$$

with centre located by the rear of the cartridge and

$$l_{107} = 53,90 \text{ mm} \pm 0,50 \text{ mm (the centre of the window for the hub)}$$

#### 8.12 Pad Printing Areas (figure 19)

The cartridge shall have two areas designated for pad printing, logo moulding, or labeling as defined by the following dimensions:

$$l_{213} = 15,00 \text{ mm nominal from the centreline of the cartridge}$$

$$l_{214} = 15,00 \text{ mm nominal from the centreline of the cartridge}$$

$$l_{215} = 5,00 \text{ mm nominal from the curve bound by the handling grip}$$

$$l_{216} = 5,00 \text{ mm nominal from the outside edge of the cartridge}$$

The second area shall be the mirror image of the first area reflected about the centreline of the cartridge.

#### 8.13 Opacity

There shall be less than 5 % transmission passing through any two walls of the cartridge case for wavelengths from 600 nm to 1 100 nm.

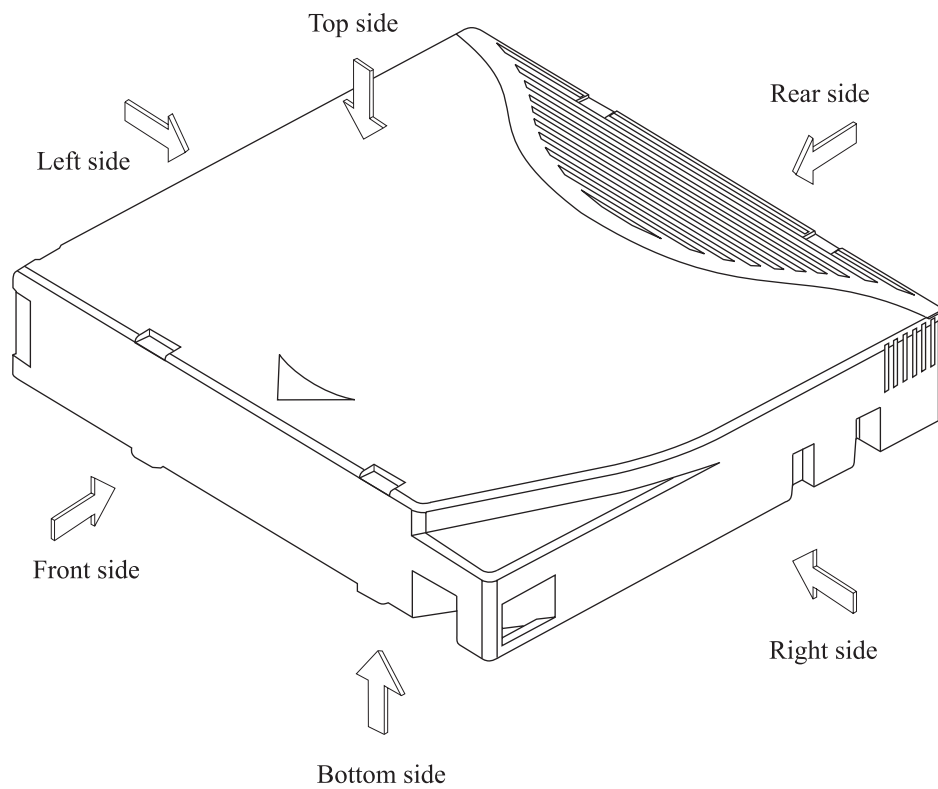


**Figure 1 - General view of the cartridge**

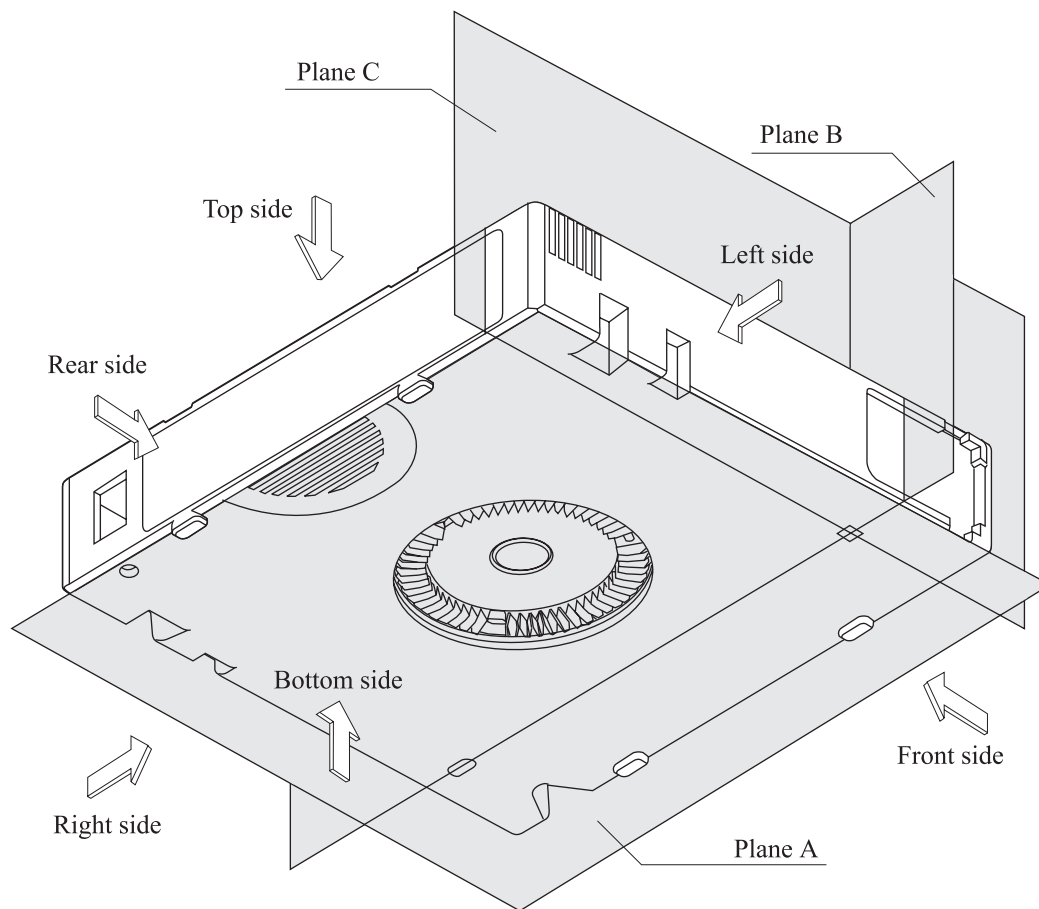


Figure 2 - View of the Reference Planes A, B, and C

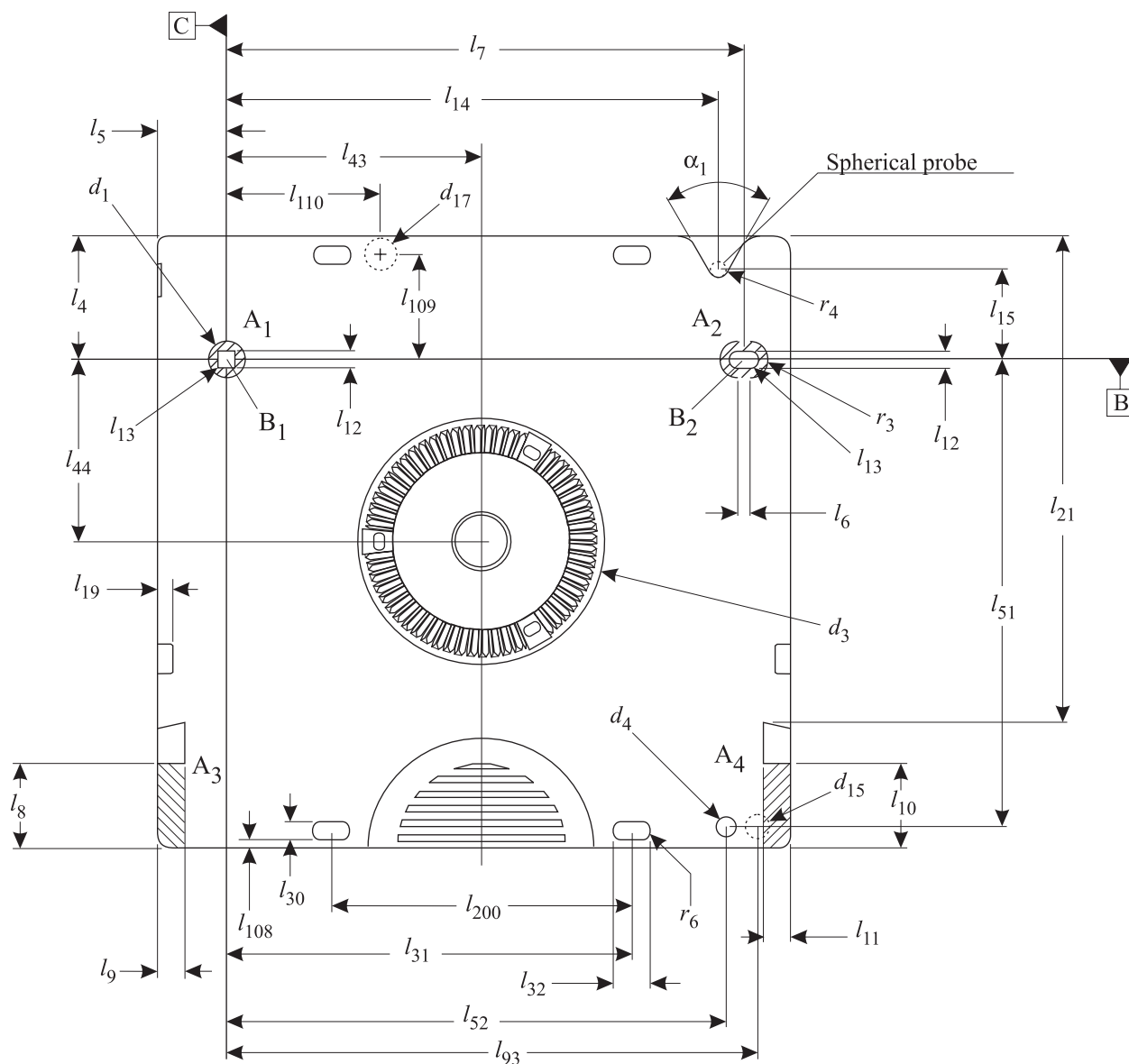


Figure 3 - Bottom side

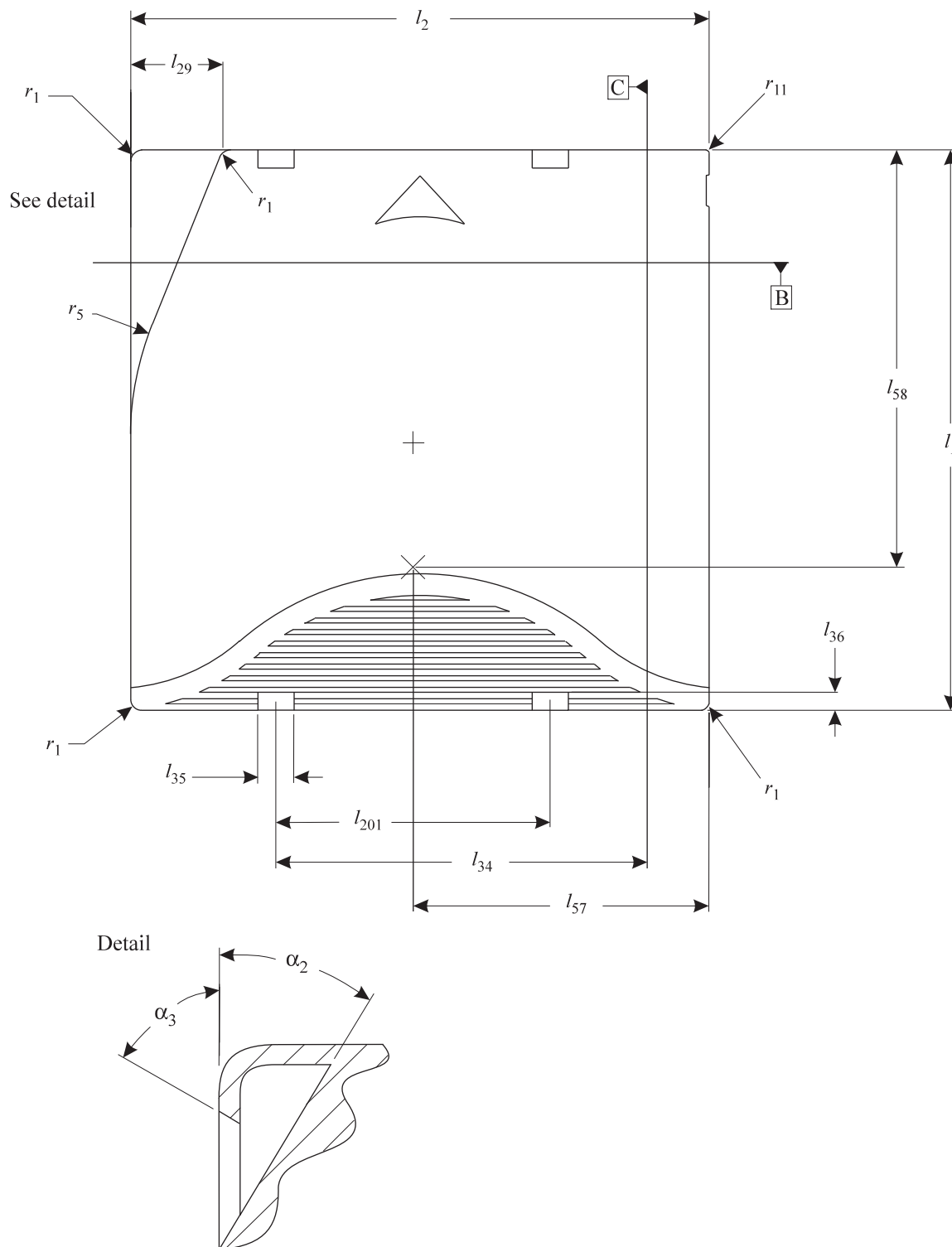


Figure 4 - Top side

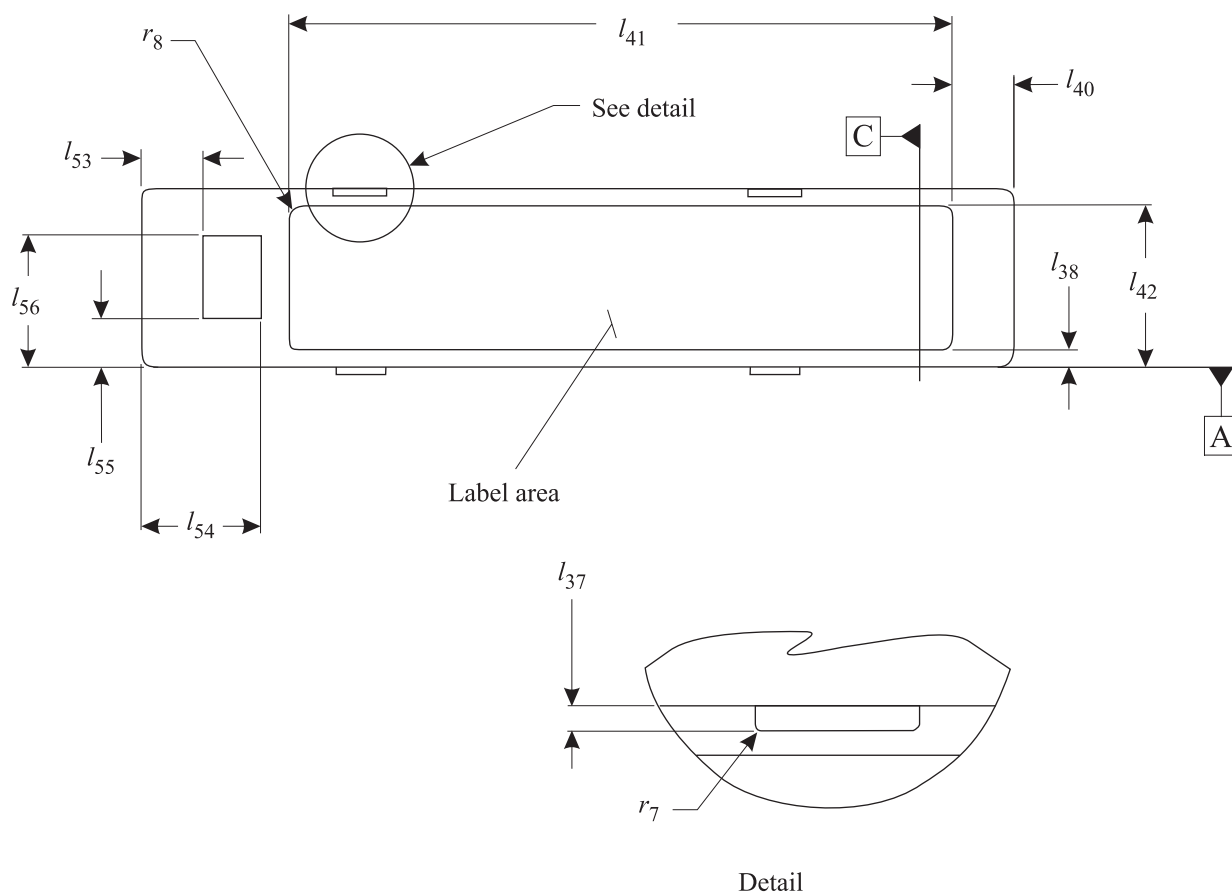


Figure 5 - Rear side

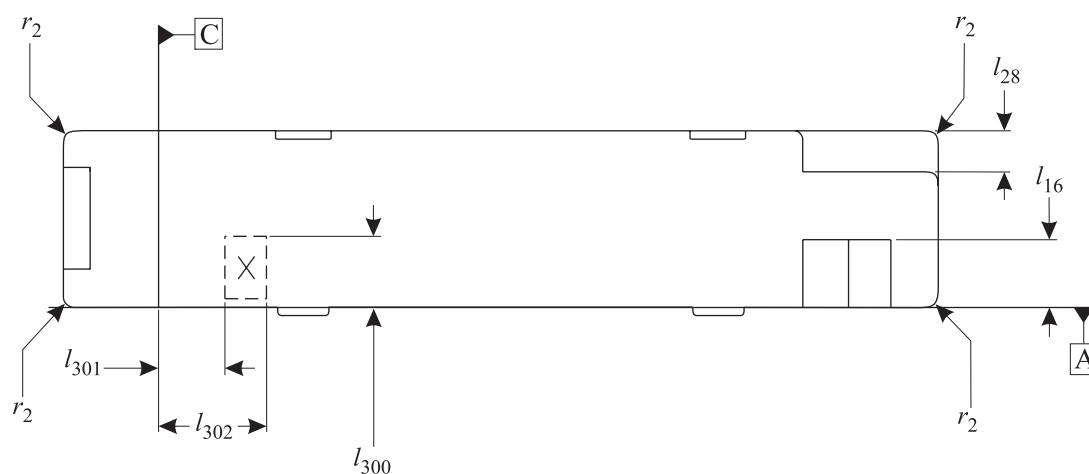


Figure 6 - Front side

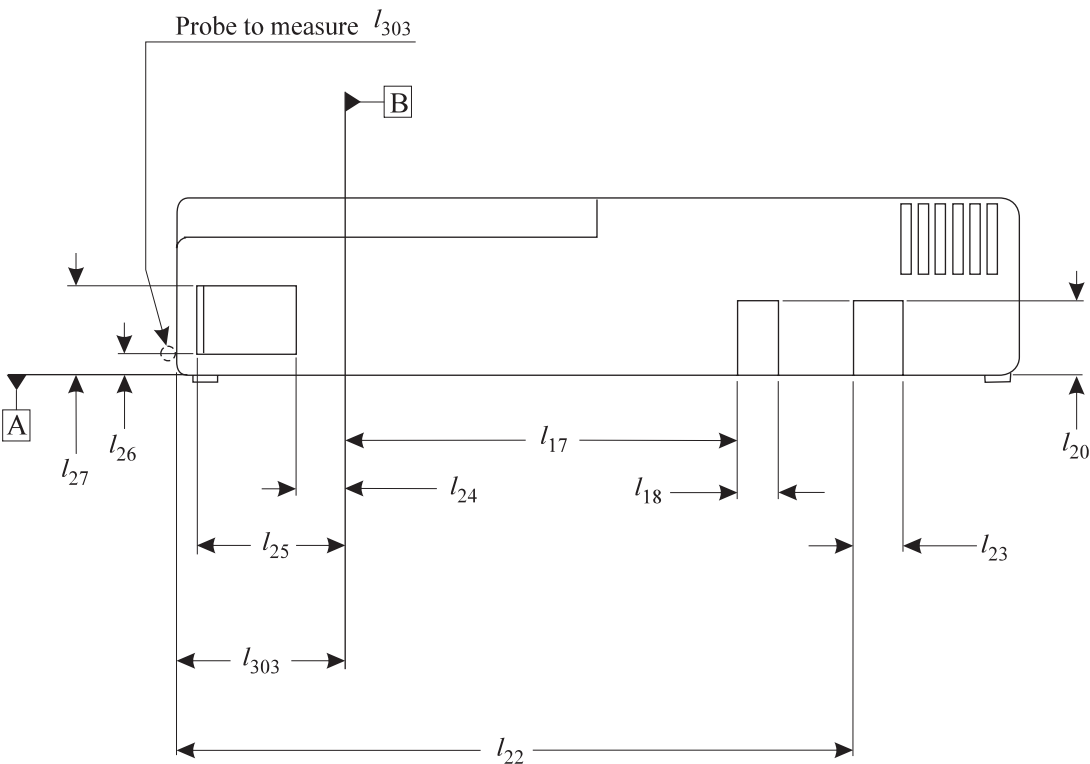


Figure 7 - Right side

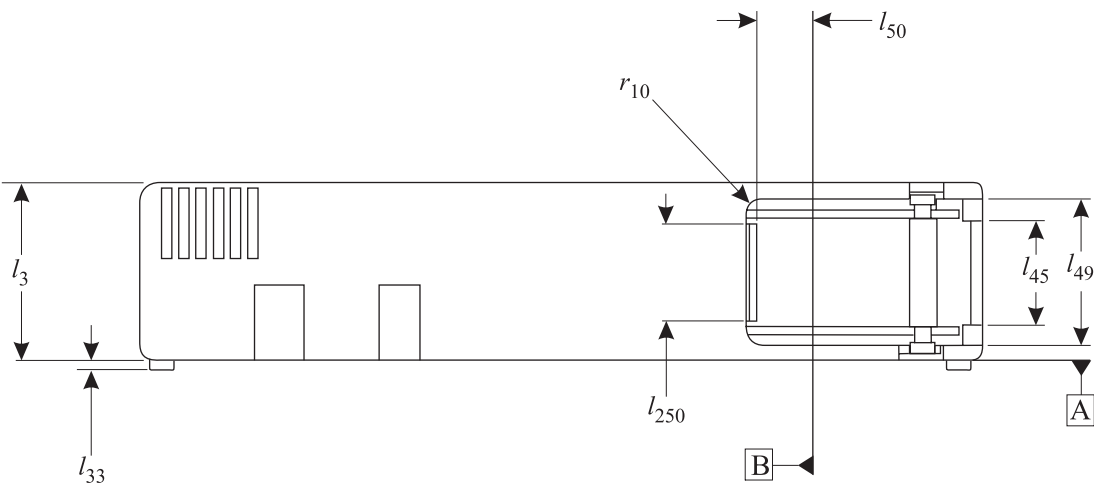


Figure 8 - Left side with access door open

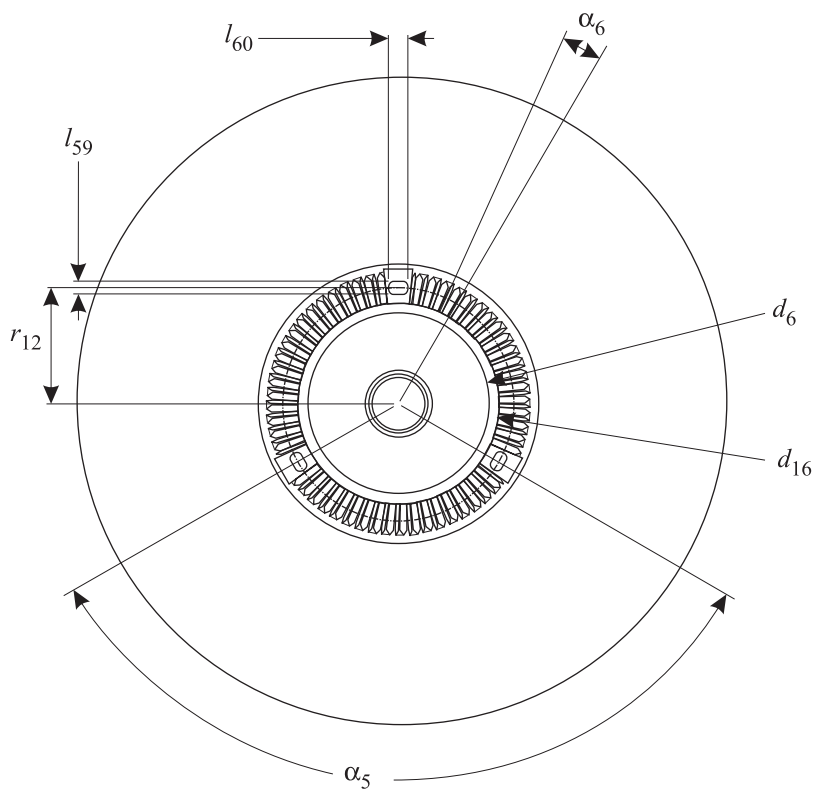


Figure 9 - Locking pad features in the reel

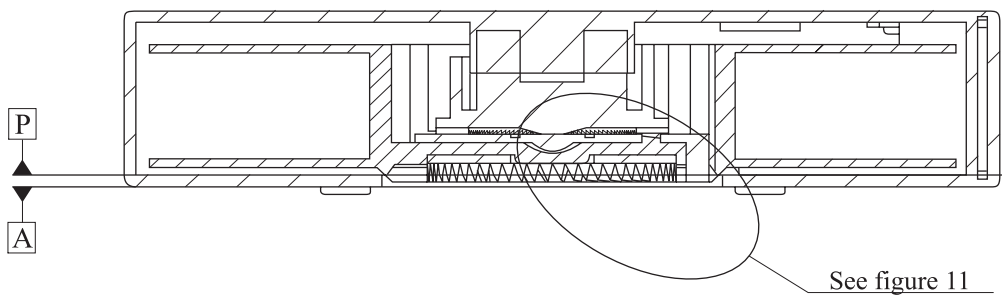


Figure 10 - Cross-section of the hub/brake assembly in the in-hand position

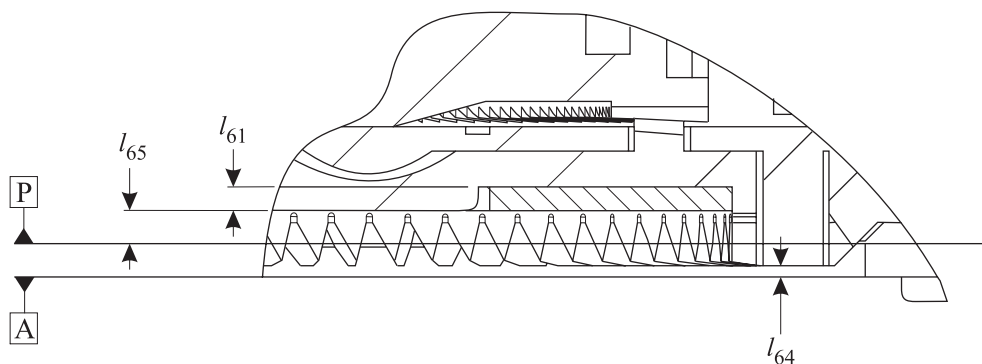


Figure 11 – Enlarged partial view from figure 10

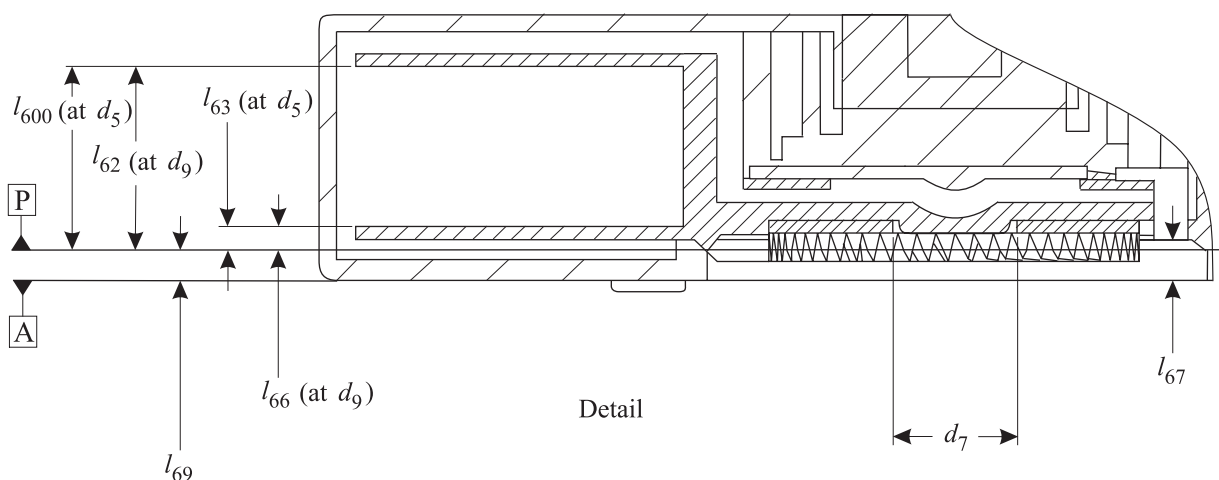
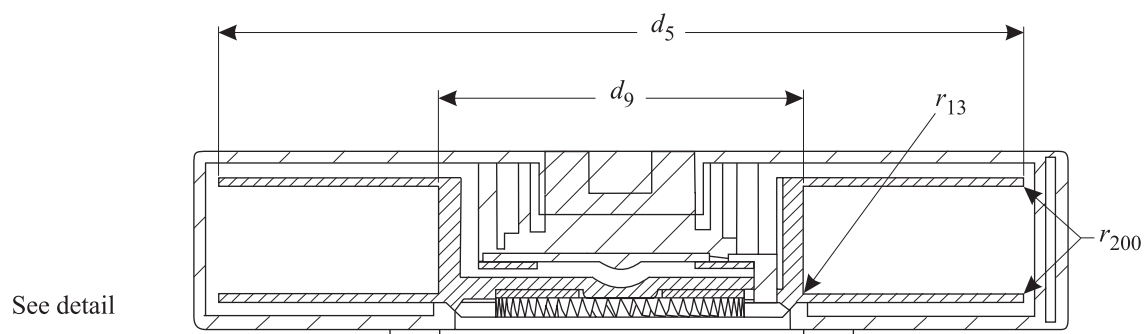


Figure 12 - Cross-section of the hub/brake assembly in the cartridge-in-drive position

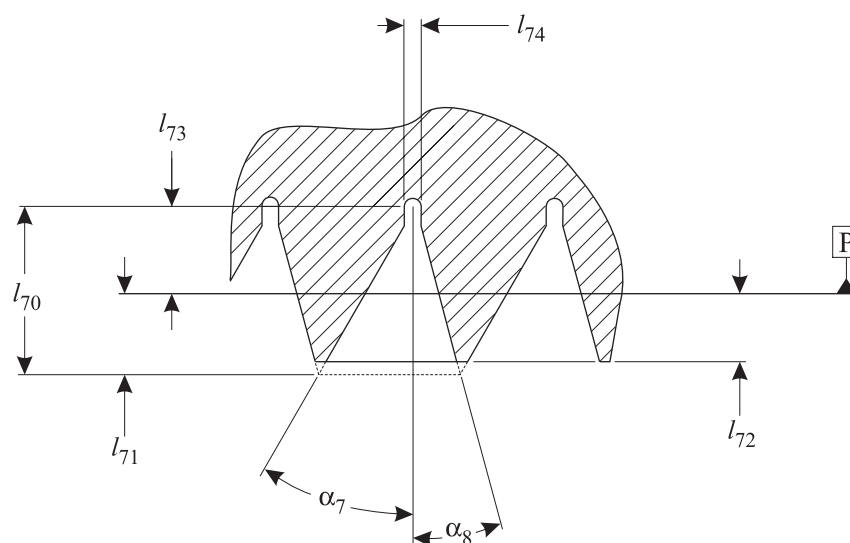


Figure 13 – Cross-section as viewed toward centre of reel through the teeth at diameter 37,50 mm

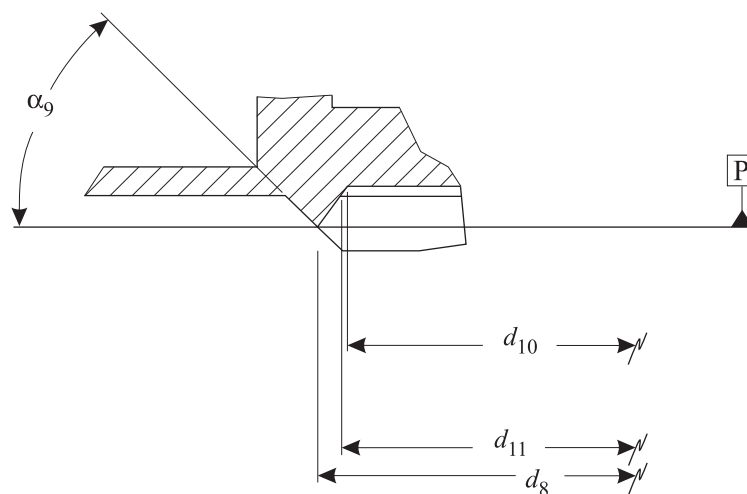


Figure 14 – Cross-section of a tooth part

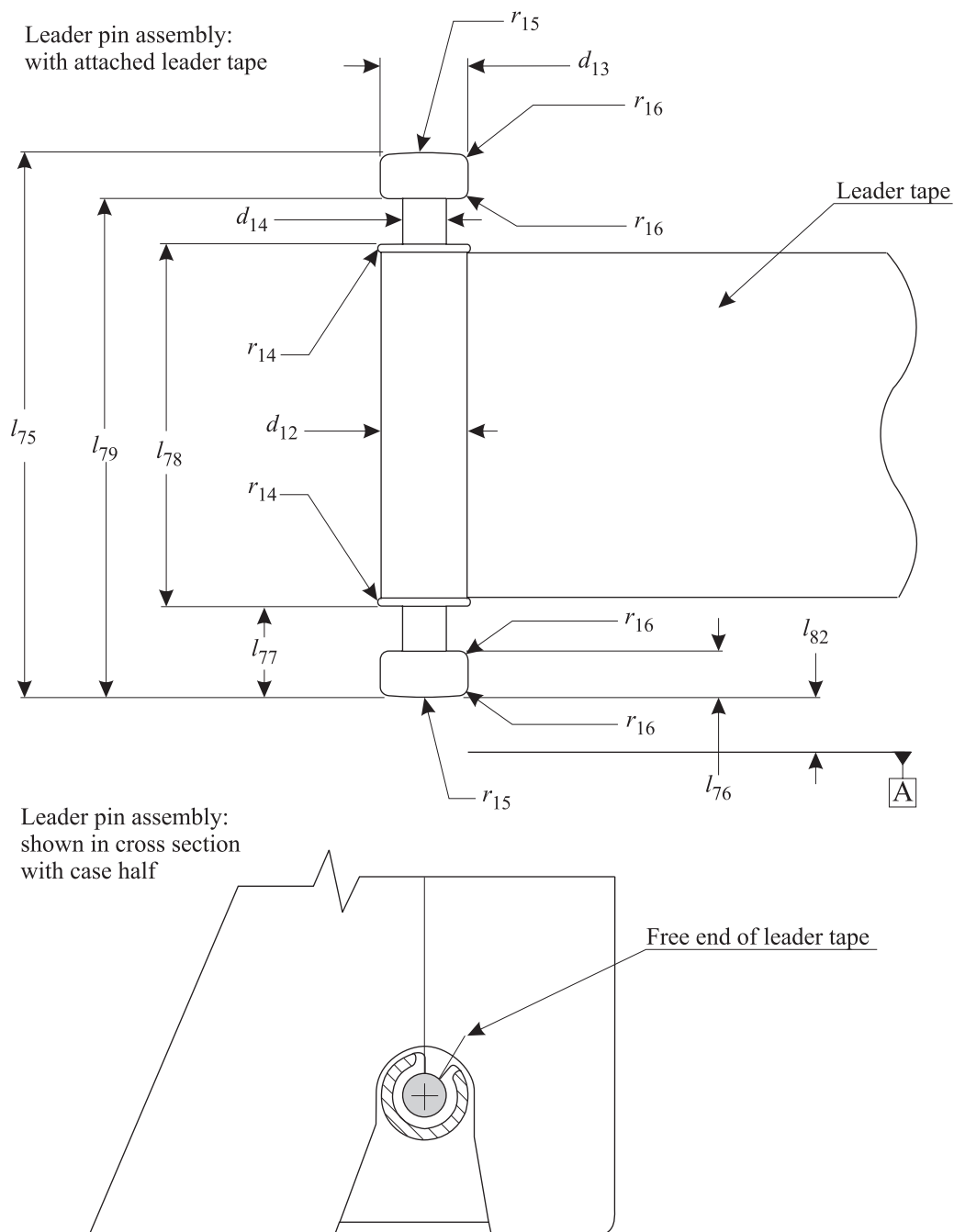


Figure 15 - Leader pin assembly with attached tape seen from the top and from the side

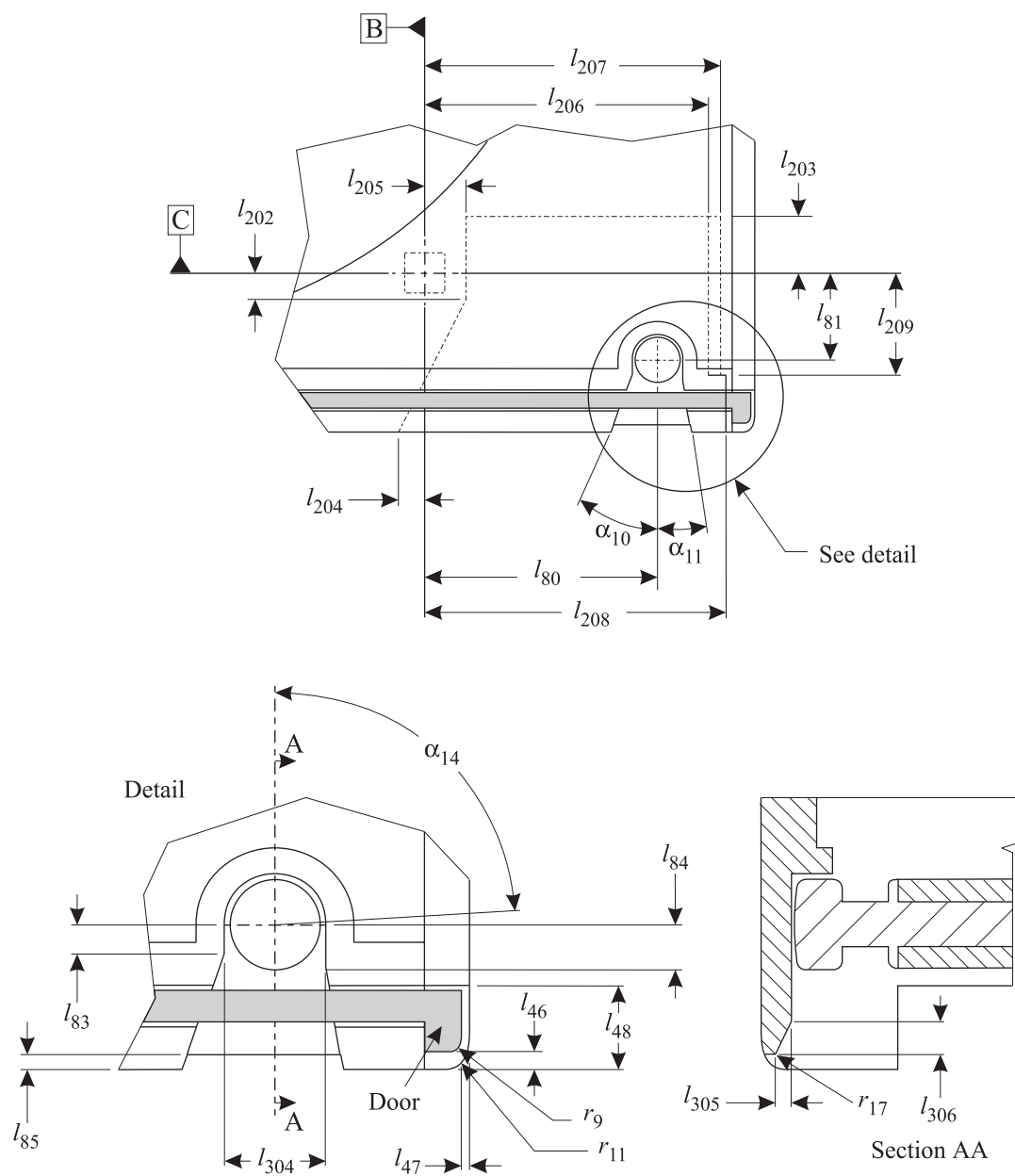


Figure 16 - Leader pin assembly in parked position and detail of the door in closed position

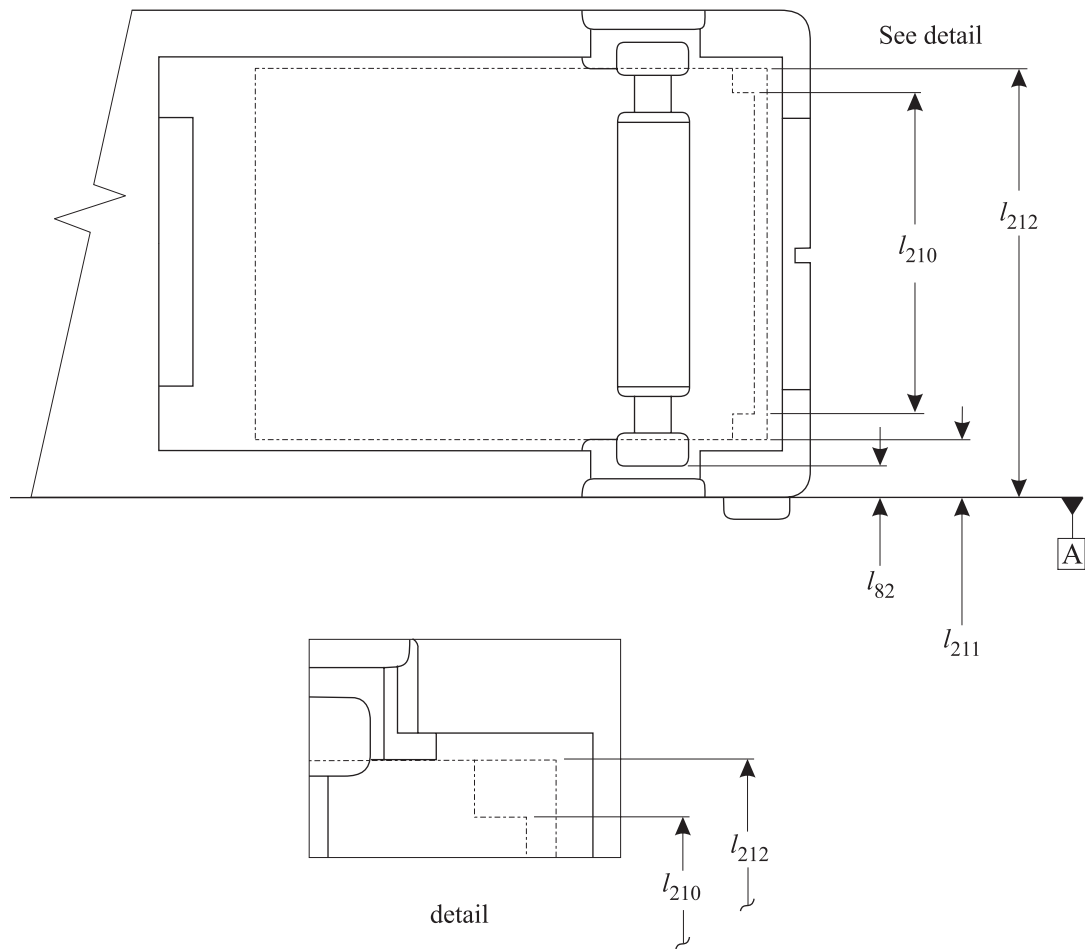


Figure 17 - Leader pin assembly in parked position and door in open position, viewed from the left side