

ISO/IEC 22050:2002-10 (E)

Information technology_- Data interchange on 12,7_mm, 384-track magnetic tape cartridges_- Ultrium-1 format

Contents

Section 1 – General

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

| | | |
|---|---|----------|
| 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 |
| Section 2 - Requirements for the Cartridge | | 8 |
| 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 |
| Section 3 - Requirements for the Unrecorded Tape | | 35 |
| 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 |

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

| | | |
|--|---|-----------|
| 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 |
| Section 4 - Requirements for an Interchanged Tape | | 45 |
| 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 |

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

| | | |
|----------------|---|------------|
| 15.6 | Amble CQs | 80 |
| 15.7 | Beginning of Wrap (BOW) | 81 |
| 15.8 | End of Wrap (EOW) | 81 |
| 15.9 | Appending and Overwriting | 81 |
| 15.10 | Servo Tracking Faults | 82 |
| | | |
| Annexes | | |
| A | - Measurement of Bit Shift | 83 |
| B | - Measurement of Broad Band Signal-to-Noise Ratio | 84 |
| C | - Tape Abrasivity Measurement Procedure | 86 |
| D | - LTO Cartridge Memory | 88 |
| E | - Flexural Rigidity Procedure | 107 |
| F | - LTO CM electrical interface | 109 |
| G | - Recommendations for transportation | 126 |
| H | - Inhibitor Tape | 127 |
| I | - Vendor code lists | 128 |