Kansas City standard

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The SWTPC AC-30 Cassette Interface implemented the Kansas City standard. It sold for $80 in May 1976.

The **Kansas City standard** (**KCS**), or **Byte standard**, is a way of storing digital data on standard cassette tapes at a data rate of 300 bits per second. It originated in a symposium sponsored by *Byte* magazine in November 1975 in Kansas City, Missouri to develop a standard for the storage of digital microcomputer data on inexpensive consumer quality cassettes. The first systems based on the standard appeared in 1976.

One variation on the basic standard is **CUTS**, which is identical at 300 bit/s, but with an optional 1200 bit/s mode. CUTS is the default encoding used by several later machine families, including those from Acorn and the MSX. MSX added a higher 2400 bit/s mode that is otherwise similar. The 1200 bit/s mode of CUTS was used as the standard for cross-platform BASICODE distribution.

Although KCS originated from the earliest days of the microcomputer revolution, it failed to prevent a proliferation of alternative encodings. Most home computers of the era have unique formats that are incompatible with KCS or each other.

History[edit]

Early microcomputers generally use punched tape for program storage, an expensive option. Computer consultant Jerry Ogdin conceived the use of audio tones on a cassette to replace the paper tapes. He took the idea to Les Solomon, editor of *Popular Electronics* magazine, who was similarly frustrated by punched tapes. In September 1975 the two co-authored an article on the HITS (Hobbyists' Interchange Tape System), using two tones to represent 1s and 0s. Soon after, a number of manufacturers started using similar approaches, although each of these systems are incompatible.[1]

Wayne Green, who had just started *Byte* magazine, wanted all the manufacturers to get together and produce a single cassette standard. He organized a two-day meeting on 7–8 November 1975 in Kansas City, Missouri.[2] The participants settled on a system based on Don Lancaster's design. After the meeting, Lee Felsenstein (of Processor Technology) and Harold Mauch (of Percom) wrote the standard, which was published in *Byte* magazine's first issue.[3]

A KCS cassette interface is similar to a modem connected to a serial port. The 1s

and 0s from the serial port are converted to audio tones using audio frequency-shift keying (AFSK). A "0" bit is represented as four cycles of a 1200 Hz sine wave, and a "1" bit as eight cycles of 2400 Hz. This gives a data rate of 300 baud. Each frame starts with one "0" start bit, followed by eight data bits (least significant bit first) followed by two "1" stop bits, so each frame is 11 bits, for a data rate of 27+3⁄11 bytes per second.

The February 1976 issue of *Byte* has a report[4] on the symposium, and the March issue features two hardware examples by Don Lancaster[5] and Harold Mauch.[6] The 300 baud rate is reliable, but slow; a typical 8-kilobyte BASIC program takes five minutes to load. Most audio cassette circuits support higher speeds.

According to Solomon, the efforts were unsuccessful: "Unfortunately, it didn't last long; before the month ended, everyone went back to his own tape standard and the recording confusion got worse."[1]

The participants of the Kansas City symposium include these:[4]

- Ray Borrill, Bloomington, Indiana
- Hal Chamberlin, The Computer Hobbyist, Raleigh, North Carolina
- Richard Smith, The Computer Hobbyist, Raleigh, North Carolina
- Tom Durston, MITS, Albuquerque, New Mexico
- Bill Gates, MITS, Albuquerque, New Mexico
- Ed Roberts, MITS, Albuquerque, New Mexico
- Bob Zaller, MITS, Albuquerque, New Mexico
- Lee Felsenstein, LGC Engineering / Processor Technology, Berkeley, California
- Les Solomon, Popular Electronics Magazine, New York, New York
- Bob Marsh, Processor Technology, Berkeley, California
- Joe Frappier, Mikra-D, Bellingham, Massachusetts
- Gary Kay, Southwest Technical Products Corp, San Antonio, Texas
- Harold A Mauch, Pronetics/Percom Data, Garland Texas
- Bob Nelson, PCM, San Ramon, California
- George Perrine, HAL Communications Corp, Urbana, Illinois
- Paul Tucker, HAL Communications Corp, Urbana, Illinois
- Michael Stolowitz, Godbout Electronics, Oakland, California
- Mike Wise, Sphere, Bountiful, Utah

Enhancements[edit]

The original standard records data as "marks" (one) and "spaces" (zero). A mark bit consists of eight cycles at a frequency of 2400 Hz, and a space bit consists of four cycles at a frequency of 1200 Hz. A word, usually one byte (8 bits) long, is recorded in little endian order, which is least significant bit first. 7-bit words are followed by a parity bit.

Processor Technology developed the popular CUTS (Computer Users' Tape Standard), which works at either 300 or 1200 baud. They provided the S-100 bus CUTS Tape I/O interface board, which offers both CUTS and Kansas City standard support to any S-100 system.

The Tarbell Cassette Interface, which, according to early PC retailer Stan Veit, "became a *de facto* standard for S-100 computers", supported the Kansas City

Standard in addition to the Tarbell "native" mode ("Tarbell standard").[7]

Acorn Computers Ltd implemented a 1200-baud variation of *CUTS* in its BBC Micro[8] and Acorn Electron microcomputers, which reduced a "0" bit to one cycle of a 1200 Hz sine wave and a "1" bit to two cycles of a 2400 Hz wave. Standard encoding includes a "0" start bit and "1" stop bit around every 8 bit piece of information, giving an effective data rate of 960 bits per second. Also, these machines record data in 256-byte blocks interspersed with gaps of carrier tone, each block carrying a sequence number and a CRC checksum, so that it is possible to rewind the tape and retry from the failed block when a read error occurs.

The MSX by default supports both a 1200 baud variation of the standard with the same bit encoding as Acorn's, and a 2400 baud variant which doubles the audio rate — a "0" bit is one cycle of a 2400 Hz wave and a "1" bit is two cycles of a 4800 Hz wave.[9] Unlike Acorn machines, the MSX uses two "1" stop bits in addition to one "0" start bit, so the effective rate at 1200 baud is approximately 873 bits per second, and the effective rate at 2400 baud is approximately 1,745 bits per second. The machine's BIOS can read data at up to 3600 baud from an ideal audio source. The Quick CUTS standard proposed by Bob Cottis and Mike Blandford and published in the Amateur Computer Club newsletter also operated at 2400 baud, encoding "0" as a half-cycle of 1200Hz and "1" as a whole cycle of 2400Hz. The receiver was self-clocking using a phase-locked loop. Published in 1978, it predates the 1982 patent for the similar coded mark inversion proposal.

Implementations[edit]

Early microcomputers[edit]

Several use the S-100 bus.

- Compukit UK101
- Exidy Sorcerer Optional S-100 expansion bus, standard 300 bit/s mode and a 1200 baud variant by default.
- Kim-1, MOS Technology Optional S-100 expansion bus (KIMSI), standard 300 bit/s mode and a hypertype 1200 baud variant.
- Lucas Nascom 1, 2 (which also supported a 1200 bit/s variant, see below)
- MITS Altair 8800
- Motorola MEK D1 6800 board
- Ohio Scientific C1P/ Superboard II
- Processor Tech Sol-20 Terminal Computer
- Processor Tech CUTS S-100 bus Tape I/O interface board
- SWTPC's Motorola 6800-based computers
- Tangerine Microtan 65 (300 baud CUTS — faster 2400 non-CUTS format also available)
- Eltec (German Company) Eurocom 1
- Z80 Starter Kit (1977 — Development board by SD Systems — 300 bauds — S-100 bus)

Personal computers[edit]

- ABC 80
- Acorn Computers Ltd

    - Acorn System 1 (300 baud only)[10]
    - Acorn Atom (300 baud standard / 1200 baud with the "fast cos" program from utility pack 1)
    - BBC Micro (300 and 1200 baud variations)
    - Acorn Electron (1200 baud only)
- Dick Smith Super-80 (300 baud only)
- Elektor Magazine National SC/MP Project
- Heathkit
    - Heathkit ET/ETW-3400 and 3400A Microprocessor Trainers (300, 1200, 2400 baud)[11]
    - Heathkit H8 (300 and 1200 baud)
    - Zenith Z-89 — also sold as the Heathkit H89 (300 and 1200 baud)
- MicroBee Systems
    - MicroBee (300 and 1200 baud)
- MSX (1200 and 2400 baud)
- Nascom (300 and 1200)
- Sega SC-3000 A slightly different 600 baud variant
- Triumph-Adler
    - Alphatronic PC
    - Alphatronic PC16
- Z80NE Nuova Elettronica with LX.385 interface
- Chaos Homebrew Computer

Programmable calculators[edit]

- Casio
    - FX-502P series with FA-1 interface (300 baud)
    - FX-602P series and FX-702P with FA-2 interface (300 baud)
    - Casio FX-603P and Casio FX-850P with FA-6 interface (300 and 1200 baud)
    - Casio FX-750P with FA-20 interface (300 baud)
    - Casio PB-700 with FA-11 interface (300 baud)

Other devices[edit]

- Casio PT-50 electronic keyboard with TA-1 tape interface module.
- Roland TR-707 drum machine and other musical equipment.

Alternative formats[edit]

Interface Age magazine May 1977 issue, with a Kansas City standard flexi disc floppy ROM

In August 1976 at the Personal Computing show in Atlantic City, New Jersey, Bob Marsh of Processor Technology approached Bob Jones, the publisher of *Interface Age* magazine, about pressing software onto vinyl records. Processor Technology provided an Intel 8080 program to be recorded. This test record did not work and Processor Technology was unable to devote more time to the effort.[12] Daniel Meyer and Gary Kay of Southwest Technical Products (SWTPC) arranged for Robert Uiterwyk to provide his 4K BASIC interpreter program for the Motorola 6800 microprocessor. The idea was to record the program on audio tape in the Kansas City format and then make a master record from the tape. Eva-Tone made Soundsheets on thin vinyl that would hold one song, these were inexpensive and could be bound in a magazine.[13] Bill Turner[14] and Bill Blomgren[15] of MicroComputerSystems Inc. along with Bob Jones[8] of *Interface Age* and Bud Schamburger of Holiday Inn worked with Eva-Tone and developed a successful process. The intermediate stage of recording to tape produced dropouts, so a SWTPC AC-30[16] cassette interface was connected directly to the record cutting equipment. The May 1977 issue of *Interface Age* contains the first "Floppy ROM", a 33⅓ RPM record containing about six minutes of Kansas City standard audio. The September 1978 Floppy ROM Number 5 has two sides: Apple BASIC, "the automated dress pattern", and IAPS format, "A program for writing letters".

See also[edit]

- BASICODE
- Commodore Datasette
- Fast loader
- Flexi disc
- IBM cassette tape
- Tarbell Cassette Interface
- Unified Emulator Format

Further reading[edit]

- *Feichtinger, Herwig (1987). "1.8.3. Kassettenaufzeichnung" [1.8.3. Cassette recording]. Arbeitsbuch Mikrocomputer [Microcomputer work book] (in German) (2 ed.). Munich, Germany: Franzis-Verlag GmbH. pp. 230–235. ISBN 3-7723-8022-0.*
- *Hübler, Bernd (1987) [1986]. "2.6. Kassetteninterface" [2.6. Cassette interface]. In Erlekampf, Rainer; Mönk, Hans-Joachim (eds.). Mikroelektronik in der Amateurpraxis [Micro-electronics for the practical amateur] (in German) (3 ed.). Berlin: Militärverlag der Deutschen Demokratischen Republik, Leipzig. pp. 92–99, 164–165. ISBN 3-327-00357-2. 7469332.*
- *von Cube, Marcus (2015-03-15). "CASsette IO Utilities". Archived from the original on 2017-03-14. Retrieved 2017-03-14.*

References[edit]

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2. ^ *Bunnell, David (December 1975). "BYTE Sponsors ACR Standards*

Meeting". Computer Notes. Vol. 1, no. 6. Altair Users Group, MITS Inc. p. 1. Archived from the original on 2012-03-23. Retrieved 2007-05-04.

3. ^ *Lancaster, Don (September 1975). "Serial Interface". BYTE. No. 1. Green Publishing. p. 22. Retrieved 2018-04-10.*
4. ^ Jump up to: *a b Manfred and Virginia Peschke (February 1976). "Report: BYTE's Audio Cassette Standards Symposium". BYTE. No. 6. BYTE Publications. pp. 72–73.*
5. ^ *Don Lancaster (March 1976). "Build the Bit Boffer". BYTE. No. 7. BYTE Publications. pp. 30–39.*
6. ^ *Harold A. Mauch (March 1976). "Digital Data on Cassette Recorders". BYTE. No. 7. BYTE Publications. pp. 40–45.*
7. ^ *"The IMSAI 8800". pc-history.org. Retrieved 2018-09-24.*
8. ^ *R. T. Russell, BBC Engineering Designs Department (1981). The BBC Microcomputer System. PART II — HARDWARE SPECIFICATION (Report). The British Broadcasting Corporation.*
9. ^ *"4, ROM BIOS". The MSX Red Book. Kuma Computers. 1985. ISBN 0-7457-0178-7.*
10. ^ Acorn System 1 Technical Manual, p.15: "On the keyboard is a Computer Users Tape Standard interface"
11. ^ *"Cassette replacement for a Heathkit ET-3400A trainer".*
12. ^ *Jones, Robert S. (May 1977). "The Floppy ROM Experiment". Interface Age. McPheters, Wolfe & Jones. **2** (6): 28, 83.*
13. ^ *Penchansky, Alan (November 10, 1979). "New Building for 'Soundsheets' Firm". Billboard. Vol. 91, no. 45. New York: Billboard Publications. p. 88. ISSN 0006-2510.*
14. ^ *Turner, William W. (May 1977). "Robert Uiterwyk's 4K BASIC". Interface Age. McPheters, Wolfe & Jones. **2** (6): 40–54.*
15. ^ *Blomgren, William (May 1977). "Platter BASIC: The Search for a Good, Random Access, Record Cutting Juke Box". Interface Age. McPheters, Wolfe & Jones. **2** (6): 29–36.*
16. ^ *Gary Kay (December 1976). "The Designer's Eye View of the AC-30". BYTE. Vol. 1, no. 16. BYTE Publications. pp. 98–108.*

External links[edit]

- The original Byte Magazine article
- 2-second sound sample of stored KCS file
- SWTPC.com's article on the AC-30 cassette interface
- Percom Data CIS-30 Cassette Interface Brochure
- Kansas City Tape Decoder