# Mark 5A/B/B+ Status

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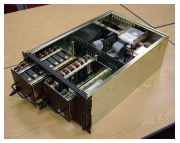
# Overview

**Systems**

- Mark 5A: 1024 Mbps
- Mark 5B: 1024 Mbps
  VSI-H interface
  Built-in formatter for telescopes
  Bypass station units at correlators
  Direct interface to DBE
- Mark 5A+: Allows Mark 5B playback (firmware)
- Mark 5B+: 2048 Mbps (Amazon StreamStor board)
- Next goal: 16 Gbps/burst mode – proposal pending


Mark 5

**Status**: ~150 Mark 5 units installed at telescopes and correlators
Mark 5A, Mark 5A+, Mark 5B and Mark 5B+ are operational
Mark 5B Correlator Interface Boards (CIBs) will ship Jan 07.



# Mark 5B Data System Features

- Full VSI-H compatibility
- Same chassis as Mark 5A; uses same disk modules; requires Mark 5B I/O card
- 1024 Mbps record/playback
- Eliminates need for external formatters, but requires sampler adapter for Mark 4/VLBA DASs to provide VSI-compatible output
- Station Unit capabilities for connection to Mark 4 correlators is designed into Mark 5B
- Extensive built-in phase-cal extraction and state counting on both data record (DIM) and data playback (DOM)
- Front-panel status display – 8 tri-color LEDs
- DIM and DOM capabilities are separate FPGA downloads
- FPGA is programmable via software

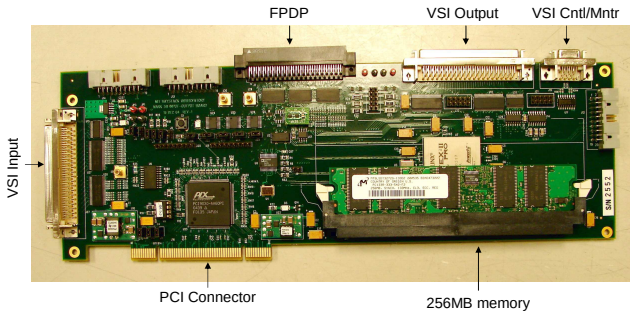
Development supported by Mark 5 development consortium –
BKG, EVN, KVN, JPL, MPI, NASA, NRAO, USNO



# Mark 5A/B/B+ System Comparisons

| | Mark 5A | Mark 5B | Mark 5B+ |
|---|---|---|---|
| Data Interface | Emulates Mark4/VLBA tape transport | VSI-H (64 MHz max clock rate) | VSI-H (64 MHz max clock rate) |
| Max data rate | 1024 Mbps | 1024 Mbps | 2048 Mbps |
| Record modes | 8, 16, 32, 64 "tracks" | 1,2,4,8,16,32 bit streams | Same as Mark 5B |
| Disks | Mark5 "8-pack" | Same | Same |
| Chassis | Mark5 | Same | Same |
| I/O card | Mark 5A | Mark 5B | Mark 5B |
| SS card | XF2 | XF2 | Amazon |
| I/O-SS interface | Modified FPDP | FPDP | FPDP2 (clocks on both edges) |

## Mark 5B I/O Board






## Mark 5B Status

- Checkout of Mark 5B hardware is complete;
  first version of DIM software has been released
- Mark 5B is in regular use at Westford antenna;
  also used in large mm experiment in April 2006
- Mark 5B is interfaced to Haystack Mark 4 correlator and in routine production use
- ~30 Mark 5B I/O boards have been built and tested
  will be distributed to Mark 5 development consortia members in near future
- Mark 5B can be ordered from Conduant Corp in Longmont, CO



## Reasons to adopt Mark 5B

- Eliminate need for expensive external formatters; particularly important for new stations or stations without existing Mark 4 or VLBA formatters
- With a 14-BBC Mark 4 or VLBA4 system, up to 1792 Mbps can be recorded with two parallel Mark 5B systems; current systems can only generate a maximum of 1024 Mbps of formatted data
- Extensive phase-cal extraction and state counting capabilities for better diagnostics and better system calibration
- Replace unreliable Station Units on Mark 4 correlators; SU capability is built into Mark 5B



## Mark 5B+ (2048 Mbps)

- Conduant has introduced an upgraded StreamStor (dubbed “Amazon”) that supports up to ~3 Gbps on FPDP2 interface
- Mark 5B I/O card has been designed to support input VSI-H clock rate of 64MHz, as well as FPDP2 DDR compatibility, to support max recording rate of 2048 Mbps with Amazon board
- May be desirable to record across 2 disk modules (16 disks) simultaneously
- Playback is limited to 1024 Mbps
- Recordings made on Amazon are playable on a standard Mark 5B or Mark 5A+ system
- Mark 5B+ can now be ordered from Conduant

## Mark 5 Upgrade Costs

| Existing \ Target | **Mark 5A** | **Mark 5B** | **Mark 5B+** |
|---|---|---|---|
| **0** | $18K | ~$20K | ~$23K |
| **Mark 5A** | - | ~$3K (Mark 5B I/O) | ~$12.5K (Mark 5B I/O plus Amazon) |
| **Mark 5B** | - | - | ~$9.5K (Amazon) |

Note: Does not include external cabling costs, typically a few hundred dollars



## Disk-Media Reliability

- We have seen only 8 disk drive failures during the past year at Haystack
  4 Hitachi, 4 Maxtor
  4 replaced under warranty
- Failure rate of Hitachi had been higher than average,
  but may now have been fixed.
- Disk reliability at high altitude was investigated in Mark 5A tests on Mauna Kea in early 2006:
  Tested disk drive types were:
  - Maxtor 300-GB Model 7L300R0
  - Seagate 300-GB Model ST3300831A
  - Western Digital 320-GB Model WD3200SB-01KMA0
  - Hitachi 250-GB Model HDS722525VLAT80

  **→Only the Hitachi's functioned reliably at 14000 ft.**
  (However, all disk drives recovered when returned to low altitude.)



## Plans for Serial-ATA Support

- A new module is being designed to support SATA disks.
- Existing 200-pin connector on module will be maintained using PATA signals.
- Conversion to SATA will be on module backplane.
- Prototype SATA modules should be ready in a few months, but we don't feel any urgency at the present time.



## Mark 5B Command Set

- Very similar to Mark 5A; many commands are the same
- New commands
  1pps_source = <1pps source>
  clock_set = <clk freq> : <clk source>
  DOT_set = <time>
  DOT_inc = <+/-n seconds>
  mode = <data source>:<bit-stream mask>:<decimation ratio>
  TVR = <tvr mask>

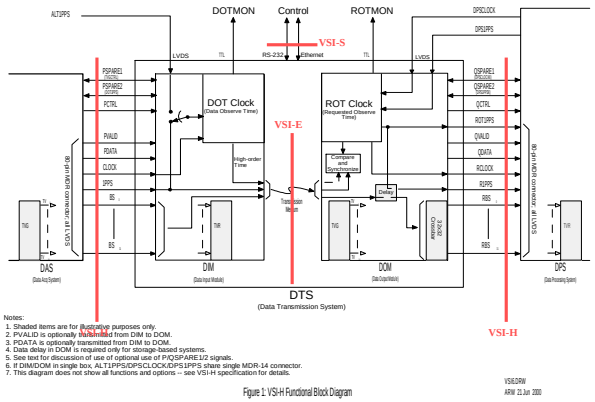
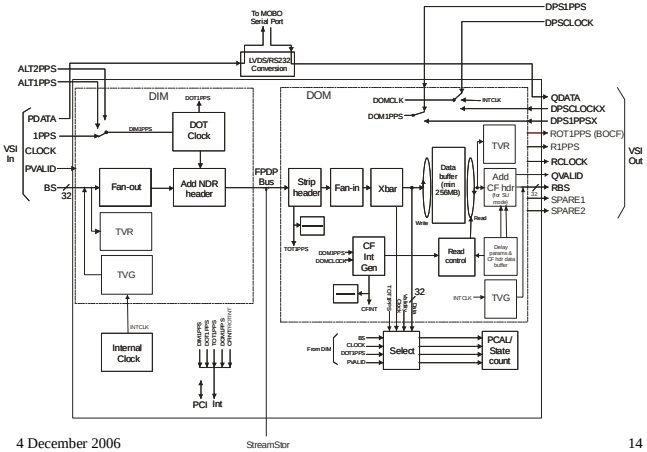



Figure 1: VSI-H Functional Block Diagram



## Mark 5B Functional Block Diagram






## Mark 5A/B Compatibility

- Mark 5B can play only Mark 5B recordings (VSI format in/out)
- Upgraded Mark 5A (“Mark 5A+”) can play:
  - All Mark 5A recordings
  - Mark 5B recordings made in almost all modes; playback is in VLBA-track-format
- Mark 5A+ design is complete and tested, but is needed only on correlators that do not yet support Mark 5B
- Existing Mark 5A systems can be upgraded to Mark 5A+ with new Xilinx download and upgraded software

Bottom line: Existing Mark 4 correlators with only Mark 5A/5A+ units will be able to process data from both Mark 5A and Mark 5B units during the transition period to Mark 5B.