

# DELKIN DEVICES®

## CFast™ Embedded Flash Module

### Engineering Specification

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# 1 General Specifications

Delkin's CFast embedded drive combines solid state reliability in a compact form factor with SATA connectivity for significant performance advantages over traditional hard disk drives. Manufactured to CFast form factor specifications established by the CompactFlash Association, the CFast embedded Module is suited to embedded industrial applications where space is restricted. Its shock, vibration, and temperature ratings permit application in extreme environments. The drives can achieve sustained read/write rates of up to 125/95MB/s and feature storage capacities from 2GB to 128GB. Delkin's CFast cards are also available in a special configuration that allows the cards to be put in a write protected state.

**Table 1. Specification Summary**

| Specification                              | Value                                                                                                                  |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Model number                               | See Table 2                                                                                                            |
| Capacity                                   | SLC: 2GB – 64GB<br>MLC: 8GB – 128GB                                                                                    |
| Interface                                  | SATA revision 2.6, compatible with SATA 1.5Gb/s and 3.0Gb/s interface rates.<br>Flash I/O: 3.3V for Asynchronous Flash |
| Form Factor                                | CFAST Type I                                                                                                           |
| Hot swappable                              | Yes                                                                                                                    |
| Environmental certifications               | RoHS, ESD, and CE/FCC                                                                                                  |
| <b>Performance</b>                         |                                                                                                                        |
| Interface burst speed                      | 1.5 or 3.0 Gb/s                                                                                                        |
| Sustained read                             | SLC: Up to 125MB/s<br>MLC: Up to 115MB/s                                                                               |
| Sustained write                            | SLC: Up to 95MB/s<br>MLC: Up to 40MB/s                                                                                 |
| <b>Reliability/Data Integrity</b>          |                                                                                                                        |
| MTBF                                       | >100,000 power on hours                                                                                                |
| Data reliability                           | 1 in 10 <sup>14</sup> bits, read                                                                                       |
| Endurance                                  | See table in Section                                                                                                   |
| <b>Power</b>                               |                                                                                                                        |
| Supply voltage (allowable)                 | 3.3V ±10%                                                                                                              |
| Typical current (configuration dependent): |                                                                                                                        |
| Idle                                       | 240 mA                                                                                                                 |
| Read                                       | 430 mA                                                                                                                 |
| Write                                      | 460 mA                                                                                                                 |

| Environmental                       |                    |
|-------------------------------------|--------------------|
| Storage temperature (°C)            | -50 ~ 100°C        |
| Operating temperature options (°C): |                    |
| • MLC Commercial                    | 0 ~ 70°C           |
| • MLC Industrial                    | -40 ~ 85°C         |
| • SLC Commercial                    | 0 ~ 70°C           |
| • SLC Industrial                    | -40 ~ 85°C         |
| Relative humidity (non-condensing)  | 95% under 55°C     |
| Vibration (operating/non-operating) | 20G (80 – 2000 Hz) |
| Shock (operating/non-operating)     | 1,500G/0.5 ms      |
| Acoustic noise                      | 0 dB               |
| Altitude                            | 80,000 feet max.   |
| Physical Dimensions                 |                    |
| Height                              | 3.6 mm             |
| Width                               | 42.8 mm            |
| Length                              | 36.4 mm            |

## 1.1 Interfaces

Figure 1 below provides a functional block diagram showing the interaction of CFast embedded MODULE components.

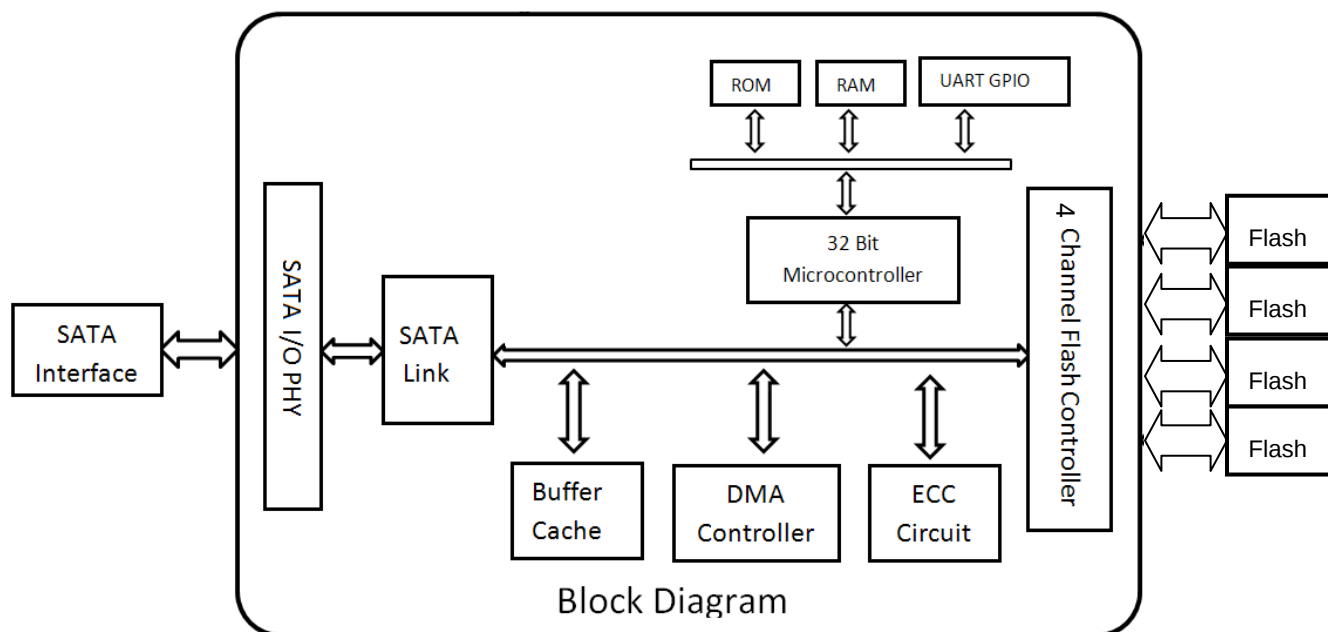


Figure 1. CFast Embedded Flash Controller Block Diagram

### 1.1.1 Electrical / Physical Interfaces

- SATA Interface—supports SATA 1.5Gbps and 3Gbps interface
- Flash IO—Asynchronous Flash (3.3V)

### 1.1.2 Controller Features

- **SATA II**
  - SATA Revision 2.6 compliant
  - Compatible with SATA 1.5Gbps and 3Gbps interface

## 1.2 Part Number Availability

Delkin CFast embedded Solid State Drives are available in the capacities shown in the table below. Drives are also available that feature Delkin's Tekta™ infusion process for greater protection in extreme environments.

**Table 2. Delkin CFast Embedded Module Capacities and Part Numbers**

| Capacity | Product Type                  | Standard Part Number | Part Number w/ Write-Protect |
|----------|-------------------------------|----------------------|------------------------------|
| 2GB      | SLC Commercial (0 to 70 °C)   | BB02TFLTK-XN000-D    | BB02TFLV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE02TFLTQ-XN000-D    | BE02TFLV9-WP000-D            |
| 4GB      | SLC Commercial (0 to 70 °C)   | BB04TFHTK-XN000-D    | BB04TFHV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE04TFHTQ-XN000-D    | BE04TFHV9-WP000-D            |
| 8GB      | MLC Commercial (0 to 70 °C)   | BA08NFWTK-XN000-D    | BA08NFWV8-WP000-D            |
|          | MLC Industrial (-40 to 85 °C) | BE08NHUTQ-XN000-D    | BE08NHUV9-WP000-D            |
|          | SLC Commercial (0 to 70 °C)   | BB08TFNTK-XN000-D    | BB08TFNV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE08TFNTQ-XN000-D    | BE08TFNTV9-WP000-D           |
| 16GB     | MLC Commercial (0 to 70 °C)   | BA16NFXTK-XN000-D    | BA16NFXV8-WP000-D            |
|          | MLC Industrial (-40 to 85 °C) | BE16NGTTQ-XN000-D    | BE16NGTV9-WP000-D            |
|          | SLC Commercial (0 to 70 °C)   | BB16TFPTK-XN000-D    | BB16TFPV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE16TFPTQ-XN000-D    | BE16TFPV9-WP000-D            |
| 32GB     | MLC Commercial (0 to 70 °C)   | BA32NFFTK-XN000-D    | BA32NFFV8-WP000-D            |
|          | MLC Industrial (-40 to 85 °C) | BE32NKBTQ-XN000-D    | BE32NKBV9-WP000-D            |
|          | SLC Commercial (0 to 70 °C)   | BB32MGGTK-XN000-D    | BB32MGGV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE32MGGTQ-XN000-D    | BE32MGGV9-WP000-D            |
| 64GB     | MLC Commercial (0 to 70 °C)   | BA64NHETK-XN000-D    | BA64NHEV8-WP000-D            |
|          | MLC Industrial (-40 to 85 °C) | BE64NKOTQ-XN000-D    | BE64NKOV9-WP000-D            |
|          | SLC Commercial (0 to 70 °C)   | BB64MGMTK-XN000-D    | BB64MGMV8-WP000-D            |
|          | SLC Industrial (-40 to 85 °C) | BE64MGMTQ-XN000-D    | BE64MGMV9-WP000-D            |
| 128GB    | MLC Commercial (0 to 70 °C)   | BA1HNHDTK-XN000-D    | BA1HNHDV8-WP000-D            |
|          | MLC Industrial (-40 to 85 °C) | BE1HNKCTQ-XN000-D    | BE1HNKCV9-XN000-D            |

\*Note: Usable capacities are within 10% of the gross capacity figures shown above, which is typical with all NAND flash devices, as a small portion of the total is needed for controller firmware and spare block reserves.

## 2 Endurance

### Endurance

The table below provides estimates of drive endurance (expressed as Terabytes Written or TBW, or Gigabytes Written or GBW) based on specific workload scenarios, using a theoretical model that takes into account the specific flash specifications in each drive configuration. Contact Delkin for endurance estimates for other specific workload scenarios.

**Table 3. Endurance Estimates by Part Number**

| Part Number(s)                         |                                        | Description                              | Sequential Write Size, 24/7 Operation |                |
|----------------------------------------|----------------------------------------|------------------------------------------|---------------------------------------|----------------|
|                                        |                                        |                                          | 1000 Bytes/Sec                        | 5000 Bytes/Sec |
| BB02TFLTK-XN000-D<br>BE02TFLTQ-XN000-D | BB02TFLV8-WP000-D<br>BE02TFLV9-WP000-D | 2GB SLC, Commercial or Industrial Grade  | 6 TBW                                 | 10 TBW         |
|                                        |                                        |                                          | 4 TBW                                 | 6 TBW          |
| BB04TFHTK-XN000-D<br>BE04TFHTQ-XN000-D | BB04TFHV8-WP000-D<br>BE04TFHV9-WP000-D | 4GB SLC, Commercial or Industrial Grade  | 13 TBW                                | 19 TBW         |
|                                        |                                        |                                          | 7 TBW                                 | 11 TBW         |
| BB08TFNTK-XN000-D<br>BE08TFNTQ-XN000-D | BB08TFNV8-WP000-D<br>BE08TFNV9-WP000-D | 8GB SLC, Commercial or Industrial Grade  | 23 TBW                                | 37 TBW         |
|                                        |                                        |                                          | 14 TBW                                | 22 TBW         |
| BB16TFPTK-XN000-D<br>BE16TFPTQ-XN000-D | BB16TFPV8-WP000-D<br>BE16TFPV9-WP000-D | 16GB SLC, Commercial or Industrial Grade | 16 TBW                                | 36 TBW         |
|                                        |                                        |                                          |                                       |                |
| BB32MGGTK-XN000-D<br>BE32MGGTQ-XN000-D | BB32MGGV8-WP000-D<br>BE32MGGV9-WP000-D | 32GB SLC, Commercial or Industrial Grade | 17 TBW                                | 72 TBW         |
|                                        |                                        |                                          |                                       |                |
| BB64MGMTK-XN000-D<br>BE64MGMTQ-XN000-D | BB64MGMV8-WP000-D<br>BE64MGMV9-WP000-D | 64GB SLC, Commercial or Industrial Grade | 33 TBW                                | 133 TBW        |
|                                        |                                        |                                          |                                       |                |
| BA08NFWTK-XN000-D                      | BA08NFWV8-WP000-D                      | 8GB MLC, Commercial Grade                | < 1 TBW                               | < 1 TBW        |
| BA16NFXTK-XN000-D                      | BA16NFXV8-WP000-D                      | 16GB MLC, Commercial Grade               | 2 TBW                                 | 6 TBW          |
| BA32NFFTK-XN000-D                      | BA32NFFV8-WP000-D                      | 32GB MLC, Commercial Grade               | < 1 TBW                               | 3 TBW          |
| BA64NHETK-XN000-D                      | BA64NHEV8-WP000-D                      | 64GB MLC, Commercial Grade               | 1 TBW                                 | 6 TBW          |
| BAH1NHDTK-XN000-D                      | BA1HNHDTV8-WP000-D                     | 128GB MLC, Commercial Grade              | 3 TBW                                 | 12 TBW         |

The figures provided are estimates and not guarantees of endurance. Actual results may vary depending on usage, operating temperature and other conditions.

## 3 Electrical Specifications

### 3.1 Pin and Signal Assignments

**Table 4. Power and Signal Pin-out**

| Pin # | CFAST | Description                          |
|-------|-------|--------------------------------------|
| S1    | SGND  | Signal Ground                        |
| S2    | A+    | SATA PAIR A                          |
| S3    | A-    |                                      |
| S4    | SGND  | Digital GND                          |
| S5    | B-    | SATA PAIR B                          |
| S6    | B+    |                                      |
| S7    | SGND  | Signal Ground                        |
| Key   |       |                                      |
| Key   |       |                                      |
| PC1   | CDI   | Card Detect In                       |
| PC2   | GND   | Ground                               |
| PC3   | NC    | No Connect                           |
| PC4   | NC    | No Connect                           |
| PC5   | NC    | No Connect                           |
| PC6   | NC    | No Connect                           |
| PC7   | GND   | Ground                               |
| PC8   | LED1  | LED Output                           |
| PC9   | LED2  | LED Output                           |
| PC10  | IO1   | Reserved (Write Protect, if enabled) |
| PC11  | IO2   | Reserved                             |
| PC112 | IO3   | Reserved                             |
| PC13  | 3.3V  | Power                                |
| PC14  | 3.3V  | Power                                |
| PC15  | GND   | Ground                               |
| PC16  | GND   | Ground                               |
| PC17  | CDO   | Card Detect Out                      |

### 3.2 Host Write Protection Schematic

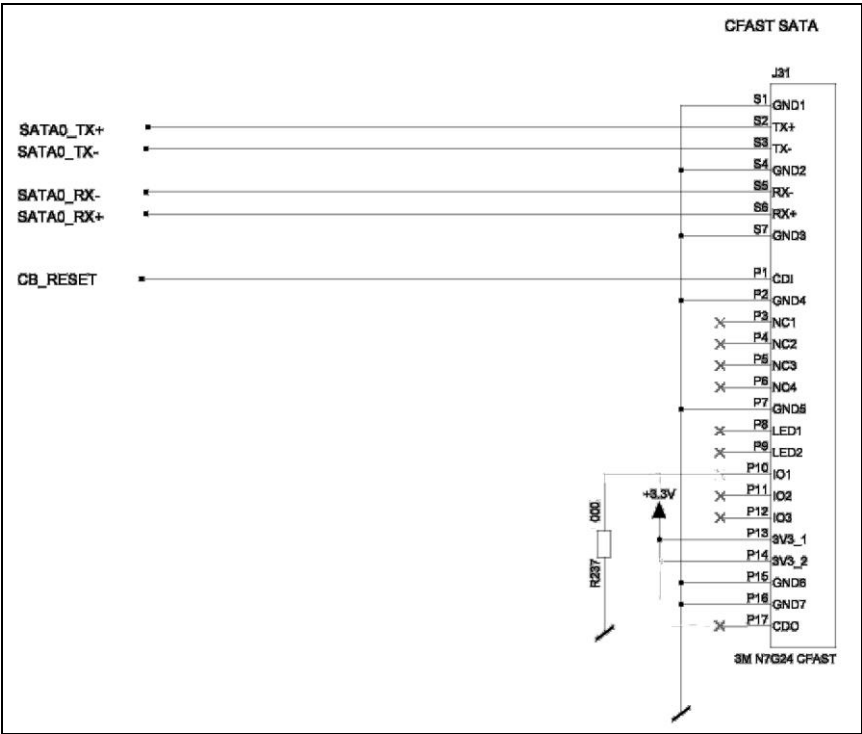


Figure 2. Schematic for Implementation of Write Protection on Enabled Devices

Note: CFast cards must have write protection capability in order to enable write protection feature. For list of part numbers with write protection capability, refer to Table 2 on page 6.

### 3.3 Supply Voltage

Table 5. Supply Voltage

| Parameter         | Rating |
|-------------------|--------|
| Operating Voltage | 3.3V   |

### 3.4 Power Consumption

Table 6. Power Consumption

| Parameter | Value (mA) |
|-----------|------------|
| Idle      | 240        |
| Read      | 430        |
| Write     | 460        |

**Note:** Values based on 128GB (256Gbit MLC x4) statistics, values may vary by capacity and flash type.

## 4 Command Descriptions

### 4.1 Supported ATA Commands

The commands listed in the following table are supported by the CFast embedded MODULE.

**Table 7. Supported ATA Commands**

| Command Name                     | Command Code (Hex) | Command Name                  | Command Code (Hex) |
|----------------------------------|--------------------|-------------------------------|--------------------|
| <b>General Feature Set</b>       |                    |                               |                    |
| Execute Drive Diagnostic         | 90h                | Flush Cache                   | E7h                |
| Identify Device                  | ECh                | Read DMA                      | C8h                |
| Read Multiple                    | C4h                | Read Sector(s)                | 20h                |
| Read Verify Sector(s)            | 40h                | Set Feature                   | EFh                |
| Set Multiple Mode                | CAh                | Write Multiple                | C5h                |
| Write Sector(s)                  | 30h                | NOP                           | 00h                |
| Read Buffer                      | E4h                | Write Buffer                  | E8h                |
| <b>Power Management</b>          |                    |                               |                    |
| Check Power Mode                 | E5h or 98h         | Idle                          | E3h or 97h         |
| Sleep                            | E6h or 99h         | Standby                       | E2h or 96h         |
| Standby Immediate                | E0h or 94h         |                               |                    |
| <b>Security</b>                  |                    |                               |                    |
| Security Set Password            | F1h                | Security Unlock               | F2h                |
| Security Erase Prepare           | F3h                | Security Erase Unit           | F4h                |
| Security Freeze Lock             | F5h                | Security Disable Password     | F6h                |
| <b>SMART Feature Set</b>         |                    |                               |                    |
| SMART Disable Operations         | B0h                | SMART Enable/Disable Autosave | B0h                |
| 30 SMART Enable Operations       | B0h                | SMART Return Status           | B0h                |
| SMART Execute Off-Line Immediate | B0h                | SMART Read Data               | B0h                |
| <b>Host Protected Area</b>       |                    |                               |                    |
| Read Native Max Address          | F8h                | Set Max Address               | F9h                |
| Set Max Set Password             | F9h                | Set Max Lock                  | F9h                |
| Set Max Freeze Lock              | F9h                | Set Max Unlock                | F9h                |

| <b>48-Bit address Feature Set</b> |     |                           |     |
|-----------------------------------|-----|---------------------------|-----|
| Flush Cache Ext                   | Eah | Read Sector(s) Ext        | 24h |
| Read DMA Ext                      | 25h | Read Multiple Ext         | 29h |
| Read Native Max Address Ext       | 27h | Read Verify Sector(s) Ext | 42h |
| Set Max Address Ext               | 37h | Write DMA Ext             | 35h |
| Write DMA FUA Ext                 | 3Dh | Write Multiple Ext        | 39h |
| Write Multiple FUA Ext            | CEh | Write Sector(s) Ext       | 34h |

## 4.2 Identity Device Data

The following table details the sector data returned by the `IDENTIFY DEVICE` command.

**Table 8. Device Sector Data**

| Word  | F: Fixed<br>V: Variable<br>X: Both | Default Value | Description                                                                     |
|-------|------------------------------------|---------------|---------------------------------------------------------------------------------|
| 0     | F                                  | 045Ah         | General configuration bit-significant information                               |
| 1     | X                                  | 3FFFh         | Obsolete - Number of logical cylinders(16383)                                   |
| 2     | V                                  | 0000h         | Specific configuration                                                          |
| 3     | X                                  | 0010h         | Obsolete - Number of logical heads (16)                                         |
| 4-5   | X                                  | 02007E00h     | Retired                                                                         |
| 6     | X                                  | 003Fh         | Obsolete - Number of logical sectors per logical track (63)                     |
| 7-8   | V                                  | 0h            | Reserved for assignment by the Compact Flash Association                        |
| 9     | X                                  | 0h            | Retired                                                                         |
| 10-19 | F                                  | Varies        | Serial number (20 ASCII characters)                                             |
| 20-21 | X                                  | 0h            | Retired                                                                         |
| 22    | X                                  | 0h            | Obsolete                                                                        |
| 23-26 | F                                  | Varies        | Firmware revision (8 ASCII characters)                                          |
| 27-46 | F                                  | Varies        | Model number                                                                    |
| 47    | F                                  | 8001h         | 7:0 - Maximum number of sectors transferred per interrupt on MULTIPLE commands. |
| 48    | F                                  | 0h            | Reserved                                                                        |
| 49    | F                                  | 0F00h         | Capabilities                                                                    |
| 50    | F                                  | 4000h         | Capabilities                                                                    |
| 51-52 | X                                  | 00000200h     | Obsoleted                                                                       |
| 53    | F                                  | 0007h         | Words 88 and 70:64 valid                                                        |
| 54    | X                                  | 3FFFh         | Obsolete - Number of logical cylinders (16383)                                  |
| 55    | X                                  | 0010h         | Obsolete - Number of logical heads (16)                                         |
| 56    | X                                  | 003Fh         | Obsolete - Number of logical sectors per track (63)                             |
| 57-58 | X                                  | 00FBFC10h     | Obsolete                                                                        |

| Word  | F: Fixed<br>V: Variable<br>X: Both | Default Value           | Description                                                      |
|-------|------------------------------------|-------------------------|------------------------------------------------------------------|
| 59    | F                                  | 0100h                   | Number of sectors transferred per interrupt on MULTIPLE commands |
| 60-61 | F                                  | Varies by Card Capacity | Total number of user addressable sectors                         |
| 62    | X                                  | 0h                      | Obsolete                                                         |
| 63    | F                                  | 0007h                   | Multi-word DMA modes supported/selected                          |
| 64    | F                                  | 0003h                   | PIO modes supported                                              |
| 65    | F                                  | 0078h                   | Minimum Multiword DMA transfer cycle time per word               |
| 66    | F                                  | 0078h                   | Manufacturer's recommended Multiword DMA transfer cycle time     |
| 67    | F                                  | 0078h                   | Minimum PIO transfer cycle time without flow control             |
| 68    | F                                  | 0078h                   | Minimum PIO transfer cycle time with IORDY flow control          |
| 69-70 | F                                  | 0h                      | Reserved                                                         |
| 71-74 | F                                  | 0h                      | Reserved for the IDENTIFY PACKET DEVICE command                  |
| 75    | F                                  | 0h                      | Queue depth                                                      |
| 76    | F                                  | 0002h                   | Serial SATA capabilities                                         |
| 77    | F                                  | 0h                      | Reserved for future Serial ATA definition                        |
| 78    | F                                  | 0000h                   | Serial ATA features supported                                    |
| 79    | V                                  | 0000H                   | Serial ATA features enabled                                      |
| 80    | F                                  | 00F8h                   | Major Version Number                                             |
| 81    | F                                  | 0021h                   | Minor Version Number                                             |
| 82    | F                                  | 7429h                   | Command set supported                                            |
| 83    | F                                  | 7008h                   | Command set supported                                            |
| 84    | F                                  | 4000h                   | Command set/feature supported extension                          |
| 85    | V                                  | 7028h                   | Command set/feature enabled                                      |
| 86    | V                                  | 3000h                   | Command set/feature enabled                                      |
| 87    | V                                  | 4000h                   | Command set/feature default                                      |
| 88    | V                                  | 007Fh                   | Ultra DMA Modes                                                  |
| 89    | F                                  | 0000h                   | Time required for security erase unit com                        |

| Word    | F: Fixed<br>V: Variable<br>X: Both | Default Value  | Description                                                                                                                     |
|---------|------------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------|
| 90      | F                                  | 0000h          | Time required for Enhanced security erase completion                                                                            |
| 91      | V                                  | 0h             | Current advanced power management value                                                                                         |
| 92      | V                                  | 0000h          | Master Password Revision Code                                                                                                   |
| 93      | F                                  | 0h             | Hardware reset result. The contents of the bits (12:0) of this word shall change only during the execution of a hardware reset. |
| 94      | V                                  | 0h             | Vendor's recommended and actual acoustic management value                                                                       |
| 95      | F                                  | 0h             | Stream Minimum Request Size                                                                                                     |
| 96      | V                                  | 0h             | Streaming Transfer Time - DMA                                                                                                   |
| 97      | V                                  | 0h             | Streaming Access Latency - DMA and PIO                                                                                          |
| 98-99   | F                                  | 0h             | Streaming Performance Granularity                                                                                               |
| 100-103 | V                                  | Not Applicable | Maximum user LBA for 48-bit Address feature set                                                                                 |
| 104     | V                                  | 0h             | Streaming Transfer Time - PIO                                                                                                   |
| 105     | F                                  | 0h             | Reserved                                                                                                                        |
| 106     | F                                  | 0h             | Physical sector size/Logical sector size                                                                                        |
| 107     | F                                  | 0h             | Inter-seek delay for ISO-7779 acoustic testing in microseconds                                                                  |
| 108-111 | F                                  | 0h             | Unique ID                                                                                                                       |
| 112-115 | F                                  | 0h             | Reserved                                                                                                                        |
| 116     | V                                  | 0h             | Reserved                                                                                                                        |
| 117-118 | F                                  | 0h             | Words per logical Sector                                                                                                        |
| 119     | F                                  | 0h             | Supported settings                                                                                                              |
| 120     | F                                  | 0h             | Command set/Feature Enabled/Supported                                                                                           |
| 121-126 | F                                  | 0h             | Reserved                                                                                                                        |
| 127     | F                                  | 0h             | Removable Media Status Notification feature set support                                                                         |
| 128     | V                                  | 0h             | Security status                                                                                                                 |

| Word    | F: Fixed<br>V: Variable<br>X: Both | Default Value | Description                                  |
|---------|------------------------------------|---------------|----------------------------------------------|
| 129-159 | X                                  | 0h            | Vendor specific                              |
| 160     | F                                  | 0h            | Compact Flash Association (CFA) power mode 1 |
| 161-175 | X                                  | 0h            | Reserved for assignment by the CFA           |
| 176-205 | V                                  | 0h            | Current media serial number                  |
| 206-216 | F                                  | 0h            | Reserved                                     |
| 217     | F                                  | 0h            | Non-rotating media device                    |
| 218-221 | F                                  | 0h            | Reserved                                     |
| 222     | F                                  | 0h            | Reserved                                     |
| 223-233 | F                                  | 0h            | Reserved                                     |
| 234     | F                                  | 0h            | Reserved                                     |
| 235     | F                                  | 0h            | Reserved                                     |
| 236-255 | F                                  | 0h            | Reserved                                     |
| 255     | X                                  | Varies        | Integrity word (Checksum and Signature)      |

## 4.3 SMART Command Support

The Delkin Industrial CFast cards feature Self-Monitoring, Analysis and Reporting Technology (SMART). Enabled by readily-available software utilities, SMART can monitor online storage devices for failure prediction, status reporting, and bad sector detection and repair. SMART can protect against system downtime and prevent data loss.

### 4.3.1 SMART Register Values

In order to select a subcommand, the host must write the subcommand code to the device's Features Register before issuing the SMART Function Set command. The subcommands are listed below:

**Table 9. SMART Feature Register Values**

| Value | Subcommand                 | Description                                                                                                                                                                                                                |
|-------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D0h   | READ DATA                  | Retrieves SMART information from the device, which is packed into the data structure as defined in Section 4.3.2                                                                                                           |
| D1h   | READ ATTRIBUTETHRESHOLD    | This command is obsolete as of ATA-4 and later versions, but is maintained for backward compatibility.                                                                                                                     |
| D2h   | ENABLE/DISABLE AUTOSAVE    | Enables / disables optional attribute auto-save feature, however, the auto-save feature is always enabled.                                                                                                                 |
| D3h   | SAVE ATTRIBUTE VALUES      | This command is obsolete as of ATA-6 and later versions, but is maintained for backward compatibility. Attribute values are saved automatically.                                                                           |
| D4h   | EXECUTE OFF-LINE IMMEDIATE | This command initiates activities that collect SMART data or execute self-diagnostic test routines in an off-line mode or captive mode, however there are currently no self-test or off-line data collection capabilities. |
| D5h   | RESERVED                   |                                                                                                                                                                                                                            |
| D6h   | RESERVED                   |                                                                                                                                                                                                                            |
| D8h   | ENABLE SMART OPERATIONS    | This command enables access to all SMART command operations.                                                                                                                                                               |
| D9h   | DISABLE SMART OPERATIONS   | This command disables access to all SMART command operations.                                                                                                                                                              |
| DAh   | RETURN STATUS              | This command returns the reliability status of the device to the host. This reliability status is determined by comparing the number of available spare blocks to the minimum spare block threshold.                       |

If the reserved size is below the threshold, the status can be read from the Cylinder Register using the Return Status command (DAh.) Please note that D1h and D3h are obsolete commands according to ATA-7, but are still provided to maintain backward compatibility with previous ATA specifications.

### 4.3.2 SMART Data Structure

The following 512 bytes make up the device SMART data structure. Users can obtain the data using the “Read Data” command (D0h).

**Table 10. SMART Data Structure**

| Word      | F: Fixed<br>V: Variable<br>X: Both | Description                                                         |
|-----------|------------------------------------|---------------------------------------------------------------------|
| 0 - 1     | X                                  | Revision code                                                       |
| 2 – 361   | X                                  | Vendor specific                                                     |
| 362       | V                                  | Off-line data collection status                                     |
| 363       | X                                  | Self-test execution status byte                                     |
| 364 - 365 | V                                  | Total time in seconds to complete off-line data collection activity |
| 366       | X                                  | Vendor specific                                                     |
| 367       | F                                  | Off-line data collection capability                                 |
| 368 – 369 | F                                  | SMART capability                                                    |
| 370       | F                                  | Error logging capability                                            |
| 371       | X                                  | Vendor specific                                                     |
| 372       | F                                  | Short self-test routine recommended polling time (in minutes)       |
| 373       | F                                  | Extended self-test routine recommended polling time (in minutes)    |
| 374       | F                                  | Conveyance self-test routine recommended polling time (in minutes)  |
| 375 - 385 | R                                  | Reserved                                                            |
| 386 - 395 | F                                  | Firmware Version/Date Code                                          |
| 396 - 397 | F                                  | Number of initial invalid block (396 = MSB, 397 = LSB)              |
| 398 - 399 | V                                  | Number of run time bad block (398 = MSB, 399 = LSB)                 |
| 400 - 406 | F                                  |                                                                     |
| 407 - 415 | X                                  | Vendor specific                                                     |
| 416       | F                                  | Reserved                                                            |

## 4.4 Mechanical Form Factor

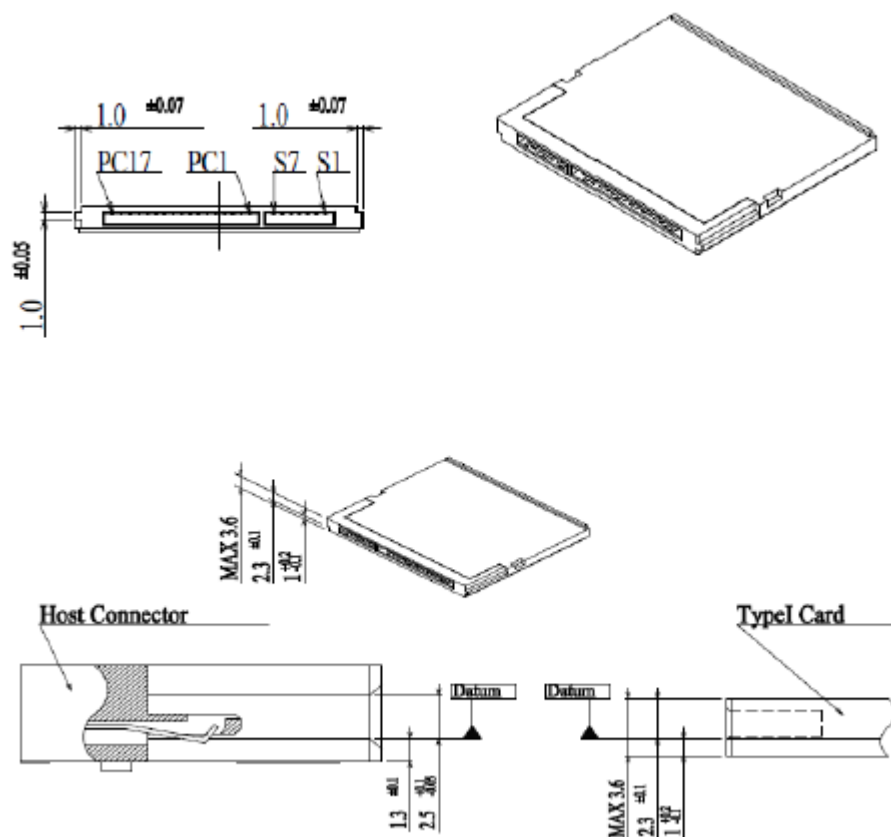


Figure 3. CFast Embedded Module Mechanical Description

4.5 Physical Dimensions

Table 11. CFast Embedded Module Physical Dimensions

| Dimension | Measurement |
|-----------|-------------|
| Height    | 3.6mm       |
| Width     | 42.8mm      |
| Length    | 36.4mm      |

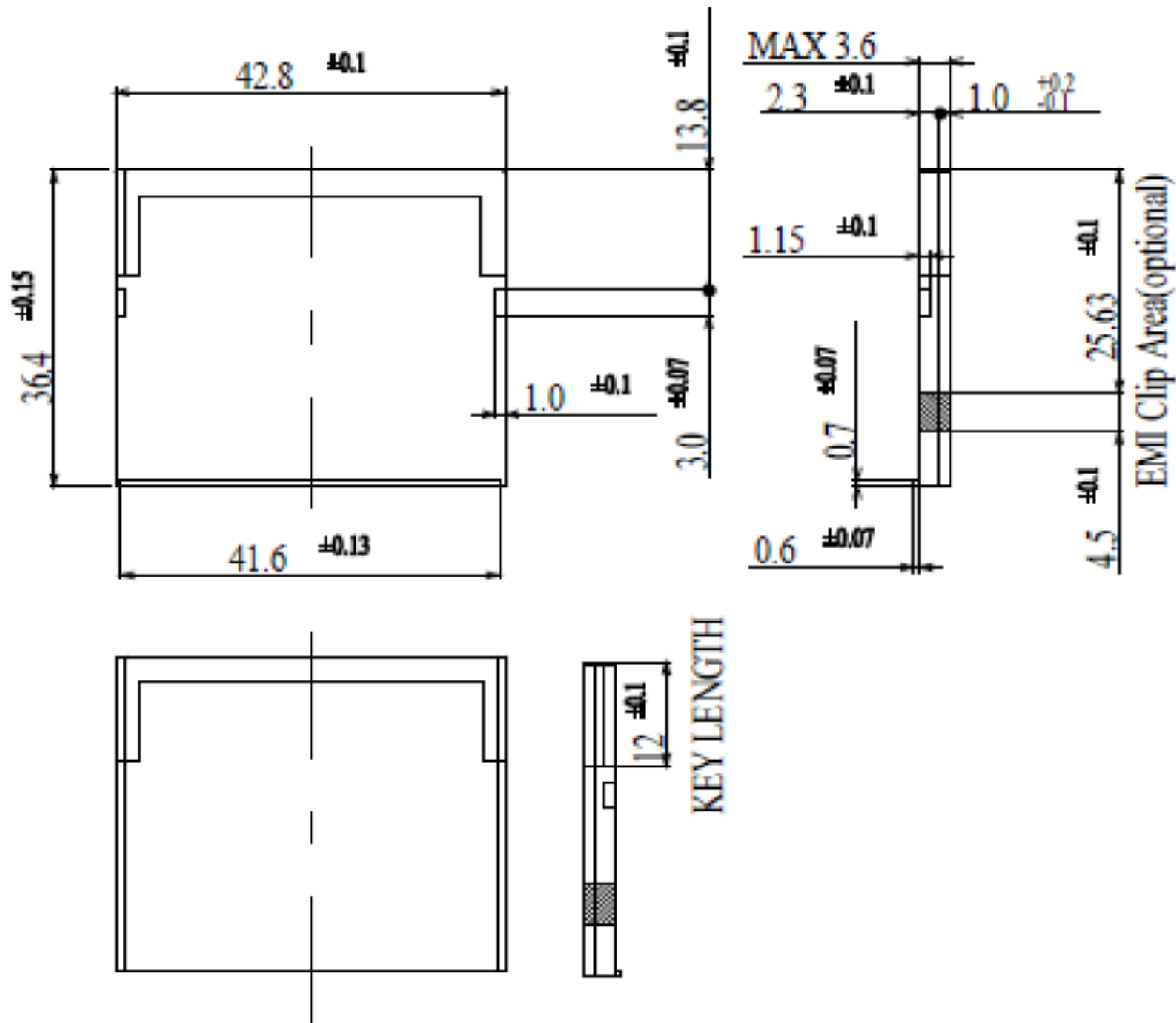


Figure 4. CFast Embedded Module Mechanical Dimensions