APRO Co., Ltd.

November 2011

Product Specification

RUFD – Generation 4

HAMMER Series

USB 2.0 Flash Disk

Doc-No: 100-xRUFD-ACS4-01V0

Revision History

Rev.	Description	Update
1.0	*Initial release*	*2011/11/8*

CONTENTS

1. Introduction

RUFD - Generation 4 – HAMMER Series, is specified as 2.0 High Speed Device, Mass Storage Class; USB-IF (USB Implementers Forum), WHQL (Window Hardware Quality Labs), EMI and IP-54/ IP-68 waterproof tests certified. In addition to being as a removable storage device, RUFD - Generation 4 can also be configured as a bootable disk for system recovery. Also, its random access performance exceed the minimum requirement of Read Boost feature found in Microsoft Vista operating system, in which randomly access blocks of information are saved into RUFD - Generation 4 for boosting up the average performance. They are available in 128MB, 256MB, 512MB, 1GB, 2GB, 4GB, and 8GB capacities by Samsung SLC Flash IC.

The RUFD - Generation 4 - HAMMER Series also offers unique customization for OEM customers by laser markings.

1.1. *Scope*

This document describes the key features and specifications of S/WRUFD – Generation 4 – HAMMER Series.

1.2. *System Features*

- Full metal enclosure design to endure various rough environments
- IP-54 & IP-68 Waterproof metal casing design
- USB 2.0 interface downwards compatible to USB 1.1
- USB 2.0 Mass Storage compliant
- Standard grade operating temperature 0°C to 70°C
- Support partition management for Disk Lock and Password Protection
- Supports Ready Boost for Microsoft Vista O.S.
- Capacities from 128MB to 8GB

2. Product Specifications

For all the following specifications, values are defined at ambient temperature and nominal supply voltage unless otherwise stated.

2.1. System Environmental Specifications

Table 1: Environmental Specification

Temperature	**Standard grade operating temperature :**	0 ºC ~ +70 ºC
	Standard grade non-operating temperature :	-20ºC ~ +80ºC
	Industrial grade operating temperature :	-40 ºC ~ +85 ºC
	Industrial grade non-operating temperature :	-50ºC ~ +95ºC
Humidity	**Operating & Non-operating:**	10% ~ 95% non-condensing
Vibration	**Operating & Non-operating:**	15G peak-to-peak maximum
Shock	**Operating & Non-operating:**	1,500 G maximum

2.2. System Power Requirements

Table 2: Power Requirement

DC Input Voltage (VCC) 100mV max. ripple(p-p)		**5V±10%**
+5V Current (Maximum average value)	**Idle Mode :**	**68.3 mA**
	Reading Mode :	**78.2 mA**
	Writing Mode :	**80.5 mA**

2.3. System Performance

Table 3: System Performances

Performance (KB/sec)	Sequent Speed (MB/Sec.)	
	Read	Write
128MB	18.2	7.6
256MB	18.3	10.0
512MB	18.3	9.7
1GB	19.9	12.2
2GB	20.5	18.7
4GB	20.5	17.5
8GB	14.9	14.5

Note:

(1). All values quoted are typically at 25℃ and nominal supply voltage.

(2). The Max. Performance was tested by SiSoftware Sandra /File Benchmark

2.4. *System Reliability*

Table 4: System Reliability

MTBF	>1,000,000 hours
Wear-leveling Algorithms	Dynamic
ECC Technology	8 bits or 12 bits per 512 bytes block
Endurance	Greater than 2,000,000 cycles Logically contributed by Wear-leveling and advanced bad sector management
Data Retention	10 years

2.5. *Physical Specifications*

Refer to Table 5 and see Figure 3 for USB Flash Disk physical specifications and dimensions.

Table 5: Physical Specifications

APRO Industrial USB Flash Disk	
Length:	54.80 mm
Width:	15.80 mm
Thickness:	15.80 mm
Weight:	25 g / 0.88 oz

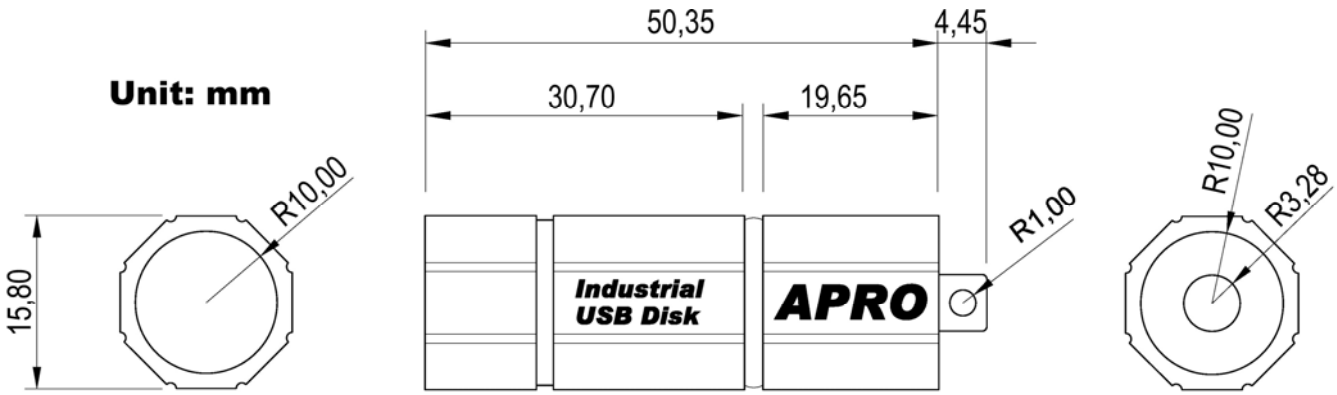

Figure 3: Generation 4 Dimensions

2.6. *Capacity Specifications*

RUFD - Generation 4 - HAMMER Series USB 2.0 Flash Disks are built-in mainly Samsung NAND Type SLC Flash memory chips. The Table 6 shows the equipollent part number of applied Samsung Flash memory chips for each USB Flash Disk.

Table 6: USB Flash Disk Configuration vs. Samsung NAND SLC part number

Capacity	Samsung SLC Flash Memory Part Number * Q'TY
128MB	K9F1G08U0A (1Gb) or equal * 1
256MB	K9F2G08U0A (2Gb) or equal * 1
512MB	K9F4G08U0M (4Gb) or equal * 1
1GB	K9K8G08U0M (8Gb) or equal * 1
2GB	K9WAG08U1M (16Gb) or equal *1
4GB	K9WBG08U1M (32Gb) or equal *1
8GB	K9NCG08U5M (64Gb) or equal *1

2.7. *Certifications*

2.7.1 EMC / Verification No.: EM/2007/90094C

APRO RUFD - Generation 4 - HAMMER Series products meet the requirements of the below standards and hence fulfills the requirements of EMC Directive 2004/108/EC requirements.

Table 7: APRO SRUFD Electromagnetic Compatibility

Parameter	Standard
Emission	EN55022 : 1998+A1: 2000+A2:2003 Class B
Immunity	EN55024 : 1998+A1: 2001+A2:2003
	IEC61000-4-2: 1995+A1:1998+A2:2000
	IEC61000-4-3: 2002+A1:2002

2.7.2 FCC / Declaration No.: EM/2007/70044C

In the configuration tested the APRO RUFD - Generation 4 - HAMMER Series complied with the standards **FCC Part 15: 2006, Subpart B, Class B.**

2.7.3 RoHS

Directive of the European Parliament of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment, 2002/95/EC (RoHS).

3. Interface Description

3.1. Physical Description

The host is connected to the RUFD - Generation 4 - HAMMER Series using a Type a female USB connector.

3.2. Pin Assignments

Table 8: Pin Assignments of USB 2.0

Pin Number	Pin Name	Function
Pin 1	Vcc	Power
Pin 2	USB -	The pairs are used to transmit Address, Data and Command.
Pin 3	USB +	
Pin 4	Vss	Ground

4. Electrical Characteristics

4.1. Absolute Maximum Ratings

Table 9: Absolute Maximum Ratings

SYMBOL	PARAMETER	RATING	UNITS
V_{DDH}	Power Supply	-0.3 to V_{DDH} + 0.3	V
V_{IN}	Input Signal Voltage	-0.3 to 3.6	V
V_{OUT}	Output Signal Voltage	-0.3 to V_{DDH} + 0.3	V
T_{STG}	Storage Temperature	-40 to 150	℃

4.2. Recommended Operating conditions

Table 10: Recommended Operating Conditions

SYSMBOL	PARAMETER	MIN	TYP	MAX	UNITS
A_{DD}	5V Power Supply	4.75	5.0	5.0	V
V_{DDH}	Power Supply	3.0	3.3	3.6	V
V_{DD}	Digital Supply	1.62	1.8	1.98	V
V_{IN}	Input Signal Voltage	0	3.3	3.6	v
T_{OPR}	Operating Temperature	0		70	℃

4.3. General DC Characteristics

Table 11: General DC Characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I_{IN}	Input current	No pull-up or pull-down	-10	±1	10	μA
I_{OZ}	Tri-state leakage current		-10	±1	10	μA
C_{IN}	Input capacitance	Pad Limit		2.8		ρF
C_{OUT}	Output capacitance	Pad Limit		2.8		ρF
C_{BID}	Bi-directional buffer capacitance	Pad Limit		2.8		ρF

4.4. DC Electrical Characteristics of 3.3V I/O Cells

Table 12: Electrical Characteristics of 3.3V I/O Cells

SYMBOL	PARAMETER	CONDITIONS	LIMITS			UNIT
			MIN	TYP	MAX	
V_{DDH}	Power supply	3.3V I/O	3.0	3.3	3.6	V
V_{il}	Input low voltage	LVTTL			0.8	V
V_{ih}	Input high voltage		2.0			V
V_{ol}	Output low voltage	$\lvert I_{ol} \rvert$ =2~16mA			0.4	V
V_{oh}	Output high voltage	$\lvert I_{oh} \rvert$ =2~16mA	2.4			V

R_{pu}	Input pull-up resistance	PU=high, PD=low	55	75	110	KΩ
R_{pd}	Input pull-down resistance	PU=high, PD=low	40	75	150	KΩ
I_{in}	Input leakage current	Vin = V_{DDH} or 0	-10	±1	10	μA
I_{oz}	Tri-state output leakage current		-10	±1	10	μA

4.5. *USB Transceiver Characteristics*

Table 13: Electrical characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
VD33	Analog supply Voltage		3.0	3.3	3.6	V
VDDU VDDA	Digital supply Voltage		1.62	1.82	1.98	V
I_{CC}	Operating supply current	High speed operating at 480 MHz			55	mA
$I_{CC(susp)}$	Suspend supply current	In suspend mode, current with 1.5kΩ pull-up resistor on pin RPU disconnected			120	μA

4.6. *Static Characteristic*

Table 14: Static characteristic: Digital pin

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Input levels						
V_{IL}	Low-level input voltage				0.8	V
V_{IH}	High-level input voltage		2.0			V
Output levels						
V_{OL}	Low level output voltage				0.2	V
V_{OH}	High-level output voltage		Vddh-0.2			V

VD33=3.0DV~3.6V；VDDU,VDDA=1.62V~1.98V；Temp=0℃~70℃

Table 15: Static characteristic: Analog I/O pin (DP / DM)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
USB 2.0 Transceiver (HS)						
Input Levels (differential receiver)						
V_{HSDIFF}	High speed differential input sensitivity	$\lvert V_{I(DP)} - V_{I(DM)} \rvert$ measured at the connection as application circuit	300			mV
V_{HSCM}	High speed data signaling common mode voltage range		-50		500	mV

V_{HSSQ}	High speed squelch detection threshold	Squelc detected			100	mV
		No squelch detected	150			mV
V_{HSDSC}	High speed disconnection detection threshold	Disconnection detected	625			mV
		Disconnection not detected			525	mV
Output Levels						
V_{HSOI}	High speed idle level output voltage (differential)		-10		10	mV
V_{HSOL}	High speed low level output voltage (differential)		-10		10	mV
V_{HSOH}	High speed high level voltage (differential)		-360		400	mV
V_{CHRPJ}	Chirp-J output voltage (differential)		700		1100	mV
V_{CHIRPK}	Chirp-K output voltage (differential)		-900		-500	mV
Resistance						
R_{DRV}	Driver output impedance	Equivalent resistance used as internal chip only	3	6	9	Ω
		Overall resistance including external resistor	40.5	45	49.5	
V_{TERM}	Termination voltage for pull-up resistor on pin RPU		3.0		3.6	V
USB 1.1 Transceiver (FS/LS)						
Input Levels (differential receiver)						
V_{DI}	Differential input sensitivity	$\lvert V_{I(DP)} - V_{I(DM)} \rvert$	0.2			V
V_{CM}	Differential common mode voltage		0.8		2.5	V
Input Levels (single-ended receivers)						
V_{SE}	Single ended receiver threshold		0.8		2.0	V
Output Levels						
V_{OL}	Low-level output voltage		0		0.3	V
V_{OH}	High-level output voltage		2.8		3.6	V

VD33=3.0DV~3.6V；VDDU,VDDA=1.62V~1.98V；Temp=0℃~70℃

4.7. *Dynamic Characteristic*

Table 16: Dynamic characteristic: Analog I/O pins (DP DM)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Driver Characteristics						
High-Speed Mode						
t_{HSR}	High-speed differential rise time	$\lvert V_{I(DP)} - V_{I(DM)} \rvert$ measured at the connection as application circuit	500			ps
t_{HSF}	High-speed differential fall time		500			ps
Full-Speed Mode						
t_{FR}	Rise time	CL=5pF ; 10 to 90% of $\lvert V_{OH} - V_{OL} \rvert$;	4		20	ns
t_{FF}	Fall time	CL=5pF ; 90 to 10% of $\lvert V_{OH} - V_{OL} \rvert$;	4		20	ns
t_{FRMA}	Differential rise / fall time matching (t_{FR} / t_{FF})	Excluding the frist transition from idle mode	90		110	%
V_{CRS}	Output signal crossover voltage	Excluding the first transition from idle mode	1.3		2.0	V
Low-Speed Mode						
t_{LR}	Rise time	CL=200pF-600pF ; 10 to 90% of $\lvert V_{OH} - V_{OL} \rvert$;	75		300	ns
t_{LF}	Fall time	CL=200pF-600pF ; 90 to 10% of $\lvert V_{OH} - V_{OL} \rvert$;	75		300	ns
t_{LRMA}	D Differential rise / fall time matching (t_{LR} / t_{LF})	Excluding the first transition from idle mode	80		125	%
V_{CRS}	Output signal crossover voltage	Excluding the first transition from idle mode	1.3		2.0	V
V_{OH}	High-level output voltage		2.8		3.6	V

Appendix A. Ordering Information

1. Part Number

RUFD - Generation 4 - HAMMER Series Industrial USB Flash Disk		
Grade	**Standard Grade 0°C ~ 70°C**	**Industrial Grade -40°C ~ 85°C**
128MB	SMUFD128M – ACCSC – 4	WRUFD128M – ACISI – 4
256MB	SMUFD256M – ACCSC – 4	WRUFD256M – ACISI – 4
512MB	SMUFD512M – ACCSC – 4	WRUFD512M – ACISI – 4
1GB	SMUFD001G – ACCSC – 4	WRUFD001G – ACISI – 4
2GB	SMUFD002G – ACCSC – 4	WRUFD002G – ACISI – 4
4GB	SMUFD004G – ACCSC – 4	WRUFD004G – ACISI – 4
8GB	SMUFD008G – ACCSC – 4	WRUFD008G – ACISI – 4

2. Part Number Decoder

X1 X2 X3 X4 X5 X6 X7 X8 X9 – X11 X12 X13 X14 X15 – 4 C

X1 : Grade
S : Standard Grade – operating temperature 0º C ~ 70 º C
W : Industrial Grade – operating temperature -40º C ~ +85 ºC

X2 : The material of case
R : Rugged Metal case

X3 X4 X5 : Product category
UFD : USB 2.0 Flash Disk

X6 X7 X8 X9 : Capacity

128M: 128MB
256M: 256MB
512M: 512MB
001G: 1GB
002G: 2GB
004G: 4GB
008G: 8GB

X11 : Controller
A : Alcor (HAMMER Series)

X12 : Controller version
A, B, C…..

X13 : Controller Grade
C : Commercial grade
I : Industrial grade

X14 : Flash IC
S : Samsung SLC-NAND Flash IC

X15 : Flash IC grade / Type
C : Commercial grade
I : Industrial grade

4 : Generation of housing design
4: Generation 4

C : Reserved for specific requirement
C: Option for Conformal-coating on PCBA

Appendix B. Limited Warranty

APRO warrants your Metal USB Flash Disk against defects in material and workmanship for the life of the drive. The warranty is void in the case of misuse, accident, alteration, improper installation, misapplication or the result of unauthorized service or repair. The implied warranties of merchantability and fitness for a particular purpose, and all other warranties, expressed or implied, except as set forth in this warranty, shall not apply to the products delivered. In no event shall APRO be liable for any lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, this product.

BEFORE RETURNING PRODUCT, A RETURN MATERIAL AUTHORIZATION (RMA) MUST BE OBTAINED FROM APRO.

Product shall be returned to APRO with shipping prepaid. If the product fails to conform based on customers' purchasing orders, APRO will reimburse customers for the transportation charges incurred.

Warranty period:

- **SRUFDxxxx-ACCSC-4** **3 years**
- **WRUFDxxxx-ACISI-4** **5 years**

The warranty period is able to extend. Please contact APRO and/or Your APRO distributors for more information.

Appendix C. After Service

1. Policy

In order to return any item for repair, an RMA (Return Merchandise Authorization) number must be assigned by APRO. Customers need to provide the following information, before an RMA will be issued:

- **Product model**
- **Quantity**
- **Lot number**
- **Defect description**
- **Customer name**
- **Contact person**
- **Email address or telephone number**
- **Shipping address**

In order to receive an RMA number, please contact our customer service department via fax or email:

- **Fax the RMA Request Form to 886-2-8226 1398. The RMA Request From can be downloaded from http://www.apro-tw.com/support/rmaform.htm)**
- **Email to rma@apro-tw.com.tw**

The description of the defect needs to be clear and complete in order for APRO to address the problem according to customer expectations. Without a clear description, APRO can only provide a basic test of the returned products.

1.1. Warranty period

SRUFDxxxx-ACCSC-4	3 years
WRUFDxxxx-ACISI-4	5 years

1.2. DOA period

If the product is found to be defective within 15 days of shipment, APRO will replace the defective product with a new unit.

1.3. Service charge under warranty period

For a warranty repair, there is no charge.

Remark:
The warranty does not cover product damage due to improper operation or force of nature such as fire or flood.

1.4. Service charge for out of warranty period

Out of warranty repair charges are dependent on component cost and labor time. APRO will issue an estimate after diagnosing the problem.

1.5. End of Life service

APRO cannot guarantee repair of any products beyond one year of End-of-Life due to limited availability of replacement components. If repair components are not available, APRO will suggest equivalent products for purchase and offer special pricing.

1.6. Shipping Charges

The customer is responsible for packaging the product such that no additional damage occurs during normal shipping and handling. Any freight-collect shipments without notice in advance will be refused.

For warranty repairs, the customer is responsible for the cost of shipping the product back to APRO. APRO will pay for shipping back to the customer.

For DOA warranty replacements, APRO will pay shipping charges for return and replacement. APRO reserves the right to use the most economical shipping method available.

2. Procedure

The definition of defective products fall into three categories as described below:

- DOA (Defect on Arrival): Defect occurs within 30 days of purchase.
- RMA in warranty period
- RMA out of the warranty period

The above terms are determined by the purchase date on the invoice up to the time to product is returned to APRO. APRO's repair service procedure is as follows:

2.1. Request an RMA Number from APRO:

(1) Fill out an "RMA Request From" and send it by fax to +886-2-8226 1398 or e-mail to rma@APRO -tw.com

(2) APRO's RMA engineer will check that the "RAM Request From" has been completed with precise information. Then the customer will receive a RMA number.
If you need a replacement rather than wait for the returned defective product to be repaired, this requirement must be noted in your "RMA Request From".

2.2. Package and Delivery to APRO

(1) Returned products have to be packed properly to avoid damage during the transportation.

(2) DOA products: DOA products qualify for complete replacement and have to be returned with all accessories included in the original purchase.

(3) Please indicate your unique RMA umber on the top outside of the package.

(4) To speed up the RMA/DOA procedure, please notify us by e-mail (rma@APRO -tw.com) with information that includes the shipping date, the name of carrier and the tracking number of the package.

2.3. Product Check On Arrival

(1) APRO's RMA engineer will check your product within 8 hours since arrival.

(2) If the product arrives undamaged and conforms to the conditions described on the "RMA Request Form", it will be for repairing.

(3) If the product is damaged or there is some inconsistency with the "RMA Request Form" description, APRO will contact and confirm the status with the customer before proceeding.

2.4. Repair

(1) The RMA engineer will repair the defect as described by the customer. The products will also be tested to ensure it is in proper working order.

(2) If no additional problems are detected, APRO will notify the customer.

(3) If the customer does not reply us within 48 hours, and no failure occurs during testing, the product will be processed as NTF. (No testing failure).

2.5. Charge

The customer will be charged for repairs under below conditions:

- RMA is out of the warranty period
- RMA or DOA terms apply, but it is determined by APRO's RMA engineer that the defect was caused by abuse, misuse or unauthorized repair.

2.6. Package and Delivery to the customer

(1) We will properly pack the repaired product along with a RMA report.

(2) The RMA number and quantity will be clearly marked on the package.

(3) The customer will receive an e-mail notification of the product RMA number and shipping advice.