FLEXXON GLOBAL LIMITED

Industrial ROBUST USB DRIVE Specification

(FxU3 I Series, MLC)

Version 1.6

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Revision History

Revision	Draft Date	History
1.0	2014/11	First release
1.1	2015/01	Update Power Consumption
1.2	2015/02	Update Physical Dimensions
1.3	2015/03	Modify table format
1.4	2015/07	Update 15nm MLC
1.5	2016/05	Add 256GB
1.6	2016/06	Update OS support

Product Overview

- **Capacity**
  - MLC: 4GB~256GB
- **Flash Interface**
  - Flash Type: MLC
- **Performance**
  - Read: up to 190MB/s
  - Write: up to 130MB/s
- **Power Consumption**
  - Max R/W: 205/210 mA
  - Standby mode: 2.5 mA
- **MTBF**
  - More than 2,000,000 hours
- **Advanced Flash Management**
  - Wear Leveling
  - Bad Block Management
  - ECC
- **Temperature Range**
  - Operation (Silver): 0°C ~ 70°C
  - Operation (Diamond): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C

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1. INTRODUCTION

1.1. General Description

FLEXXON Industrial Robust Drive is a super speed USB 3.0 removable flash disk drive with USB 3.0 connection (backward compatible with USB 2.0and USB 1.1) and supports various storage capacities.

The Industrial Robust Drive is compatible with all USB specification (USB 1.1 / USB 2.0 / USB 3.0). It is a plug and play device, simply plug it into any USB port and it will automatically get detected by the computer. Now you can read, write, copy, delete and move data from your hard disk drive to Industrial Robust Drive or from Industrial Robust Drive to your hard disk drive with the super speed of USB 3.0.

The Industrial Robust Drive is so compact that you can take it with you anywhere in your pocket. With the high capacity of the Robust Drive, you can use it as an external removable hard drive. Now, you don't have to carry a laptop computer with you to work if you have to access to a computer. "Bring your data only." Moreover, the Industrial Robust Drive does not require any battery, cables or software drivers. It is compatible with any desktop or notebook computers with USB port.

Most importantly, the Industrial Robust Drive has passed various rugged environmental tests to ensure its reliability when facing different applications and tough environments. Moreover, it uses external crystal to increase product reliability and compatibility in high temperature working environment.

Experience the reliable, light weighted, compact design, super performance, and fast data transfer with Industrial Robust Drive.

1.2. Flash Management

1.2.1. Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, FxU3 I ROBUST applies the BCH ECC algorithm, which can detect and correct errors occur during read process, ensure data been read correctly, as well as protect data from corruption.

1.2.2. Wear Leveling

NAND flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash

media are not used evenly. If some areas get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling technique is applied to extend the lifespan of NAND flash by evenly distributing write and erase cycles across the media.

FLEXXON provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND flash is greatly improved.

1.2.3. Bad Block Management

Bad blocks are blocks that include one or more invalid bits, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Initial Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. FLEXXON implements an efficient bad block management algorithm to detect the factory-produced bad blocks and manages any bad blocks that appear with use. This practice further prevents data being stored into bad blocks and improves the data reliability.

2. PRODUCT SPECIFICATIONS

- **Capacity**
  - From 4GB up to 256GB (Diamond and Silver)
- **Operation temp. range**
  - Silver: 0°C ~ 70°C
  - Diamond: -40°C ~ 85°C
- **Storage temp. range**
  - -40°C ~ 85°C
- **Compatible with USB specification revision 1.1, 2.0 and 3.0.**
- **Support current main Windows versions without device driver, including Windows 7, 8, 10 , etc.**
- **Support current main MAC OS X versions without device driver (USB 1.1 speed).**
- **Support Linux Kernel ver2.4.0 or above without device driver (USB 1.1 speed).**
- **Support Linux Kernel ver2.4.10 or above without device driver (USB 2.0 speed).**
- **Durable solid-state storage – data retention up to 10 years.**
- **No external power is required – DC 4.5V-5.5V from USB port.**
- **Transfer rate for USB interface:**
  - Super speed up to 5Gbits/sec for USB 3.0
  - High speed up to 480Mbits/sec for USB 2.0
  - Full speed up to 12Mbits/sec for USB 1.1
- **Low power consumption**
- **Performance**

Capacity	Sequential	
	Read (MB/s)	Write (MB/s)
4GB	95	7
8GB	95	20
16GB	95	25
32GB	190	45
64GB	190	95
128GB	190	95
256GB	180	130

NOTES:

1. The performance is obtained from CrystalDiskMark.
2. Samples are made of Toshiba 15nm MLC NAND flash.
3. Performance may vary from flash configuration, DDR configuration and platform.
4. The table above is for reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.

3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. Temperature and Humidity

- Temperature:
  - Storage: -40°C to 85°C
  - Operational (Silver grade): 0°C to 70°C
  - Operational (Diamond grade): -40°C to 85°C
- Humidity:
  - Silver grade: RH 93% under 40°C (in operation)
  - Diamond grade: RH 95% under 55°C (in operation)

Table 3-1 High Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	70°C	0% RH	24 hours
Operation (Diamond)	85°C	0% RH	72 hours
Storage (Silver)	85°C	0% RH	24 hours
Storage (Diamond)	85°C	0% RH	168 hours

Result: No any abnormality is detected.

Table 3-2 Low Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	0°C	0% RH	24 hours
Operation (Diamond)	-40°C	0% RH	72 hours
Storage (Silver)	-40°C	0% RH	24 hours
Storage (Diamond)	-40°C	0% RH	168 hours

Result: No any abnormality is detected.

Table 3-3 High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	40°C	93% RH	4 hours
Operation (Diamond)	55°C	95% RH	24 hours
Storage (Silver)	40°C	95% RH	48 hours
Storage (Diamond)	55°C	95% RH	96 hours

Result: No any abnormality is detected.

Table 3-4 Temperature Cycle Test

	Temperature	Test Time	Cycle
Operation (Silver)	0°C	30 min	10 cycles
	70°C	30 min	
Operation (Diamond)	-40°C	30 min	20 cycles
	85°C	30 min	
Storage (Silver)	-40°C	30 min	10 cycles
	85°C	30 min	
Storage (Diamond)	-40°C	30 min	50 cycles
	85°C	30 min	

Result: No any abnormality is detected.

3.1.2. Shock

Table 3-5 FxU3 I ROBUST Shock Specification

	Acceleration Force	Half Sin Pulse Duration
Non-operational	1500G	0.5ms

Result: No any abnormality is detected when power on.

3.1.3. Vibration

Table 3-6 FxU3 I ROBUST Vibration Specification

	Condition		Vibration Orientation
	Frequency/Displacement	Frequency/Acceleration	
Non-Operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G	X, Y, Z axis/60 min for each

Result: No any abnormality is detected when power on.

3.1.4. Drop

Table 3-7 FxU3 I ROBUST Drop Specification

	Height of Drop	Number of Drop
Non-operational	110cm free fall	6 face of each unit

Result: No any abnormality is detected when power on.

3.1.5. Bending

Table 3-8 FxU3 I ROBUST Bending Specification

	Force	Action
Non-operational	≥ 50N	Hold 1min/5times

Result: No any abnormality is detected when power on.

3.1.6. Torque

Table 3-9 FxU3 I ROBUST Torque Specification

	Force	Action
Non-operational	0.5N-m or +/-5 deg	Hold 30s/5times

Result: No any abnormality is detected when power on.

3.1.7. Durability

Table 3-10 FxU3 I ROBUST Durability Specification

	Force	Action
Non-operational	Between Extraction 10N (min) and Insertion 35N (max)	5,000times

Result: No any abnormality is detected when power on.

3.1.8. Electrostatic Discharge (ESD)

Table 3-11 FxU3 I ROBUST Contact ESD Specification

Device	Capacity	Temperature	Relative Humidity	+/- 4KV	Result
FxU3 I ROBUST	32GB	24.0°C	49% (RH)	Device functions are affected, but EUT will be back to its normal or operational state automatically.	CLASS B PASS

3.2. MTBF

MTBF, an acronym for Mean Time Between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of FLEXXON's Industrial Robust Drive (FXU3 I solution) is more than 2,000,000 hours.

3.3. Endurance

Endurance is defined by P/E cycle of the NAND flash. Moreover, the endurance will be varied depending on the usage of users.

4. ELECTRICAL SPECIFICATIONS

4.1. Absolute Maximum Rating

Item	Symbol	Parameter	MIN	MAX	Unit	Remark
1	VCC5A	5V Power	-0.6	+9.0	V	
2	VCC3IO	IO Power	-0.6	+7.5	V	
3	AVCC33	PHY 3.3V Power	-0.6	+7.5	V	
4	VCCK	AON Core Power	-0.6	+5.5	V	
5	Ta	Operating Temperature	-40	+85	°C	Diamond Grade
6	Tst	Storage Temperature	-40	+85	°C	

4.2. Power Consumption

Capacity	Power Consumption			
	Read	Write	Idle	Standby
4GB	80	75	30	2.5
8GB	80	75	30	2.5
16GB	130	150	35	2.5
32GB	130	150	35	2.5
64GB	150	160	35	2.5
128GB	170	160	35	2.5
256GB	205	210	40	2.5

Unit: mA

NOTES:

1. Samples are made of Toshiba MLC 15nm NAND Flash.
2. Power Consumption may vary from flash configuration, DDR configuration or platform.

4.3. DC Characteristic

Table 4-1 FxU3 I ROBUST DC characteristic of I/O cells

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
VCCK	Core Power Supply	Core Area	0.99	1.1	1.21	V
VCC3IO	Power Supply	1.8V I/O	1.62	1.8	1.98	V
		3.3V I/O	3.0	3.3	3.6	V
Temp	Junction Temperature		0	25	115	°C
VIL	Schmitt Trigger	VCC3IO = 3.3V	0.35 x VCC3IO			V
	CMOS Trigger		0.5 x VCC3IO			
	Two Trigger		0.45 x VCC3IO			
VIH	Schmitt Trigger		0.65 x VCC3IO			V
	CMOS Trigger		0.5 x VCC3IO			
	Two Trigger		0.55 x VCC3IO			
VIL	Schmitt Trigger	VCC3IO = 1.8V	0.41 x VCC3IO			V
	CMOS Trigger		0.53 x VCC3IO			
	Two Trigger		0.5 x VCC3IO			
VIH	Schmitt Trigger		0.69 x VCC3IO			V
	CMOS Trigger		0.53 x VCC3IO			
	Two Trigger		0.56 x VCC3IO			
V_{OL}	Output Low Voltage	|Iol| = 2~16 mA	--	--	0.4	V
V_{OH}	Output High Voltage	|Ioh|= 2~ 16 mA	VCC3IO-0.4	--	--	V
Rpu	Input Pull-Up Resistance	PU=high PD=low	40	50	190	KΩ
Rpd	Input Pull-Down Resistance	PU=low PD=high	40		190	KΩ
Iin	Input Leakage Current	Vin = VCC3I or 0	--	--	10	μA
Ioz	Tri-state Output Leakage Current		-10	±1	10	μA

4.4. AC Characteristic

4.4.1. Flash Memory Interface Timing

Below information are for reference and example use only. The actual timing, please refer to the related flash spec.

Table 4-2 FxU3 I ROBUST Flash Memory Interface Timing

Parameter	Symbol	Min	MAX	Unit
CLE Set-up Time	tCLS	0	--	ns
CLE Hold Time	tCLH	10	--	ns
CE Setup Time	tCS	0	--	ns
CE Hold Time	tCH	10	--	ns
WE Pulse Width	tWP	25	--	ns
ALE Setup Time	tALS	0	--	ns
ALE Hold Time	tALH	10	--	ns
Data Setup Time	tDS	20	--	ns
Data Hold Time	tDH	10	--	ns
Write Cycle Time	tWC	45	--	ns
WE High Hold Time	tWH	15	--	ns
Read Cycle Time	tRC	50	--	ns
/RE Pulse Width	tRP	25	--	ns
/RE High Hold Time	tREH	15	--	ns
Ready to /RE Low	tRR	60	--	ns

4.4.2. Command Latch Cycle

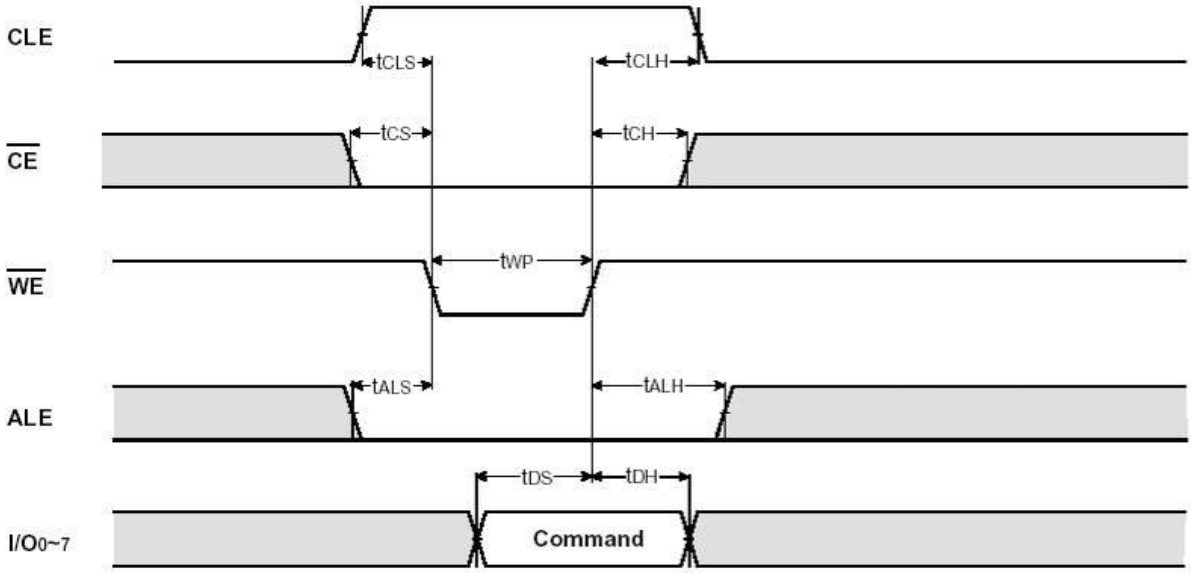


Figure 4-1 FxU3 I Command Latch Cycle

4.4.3. Address Latch Cycle

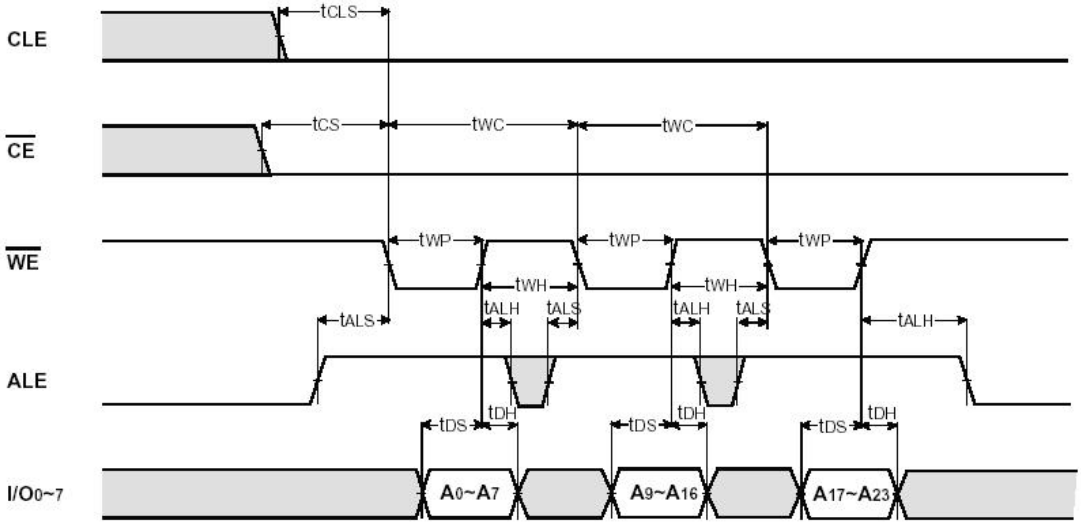


Figure 4-2 FxU3 I Address Latch Cycle

4.4.4. Input Data Latch Cycle

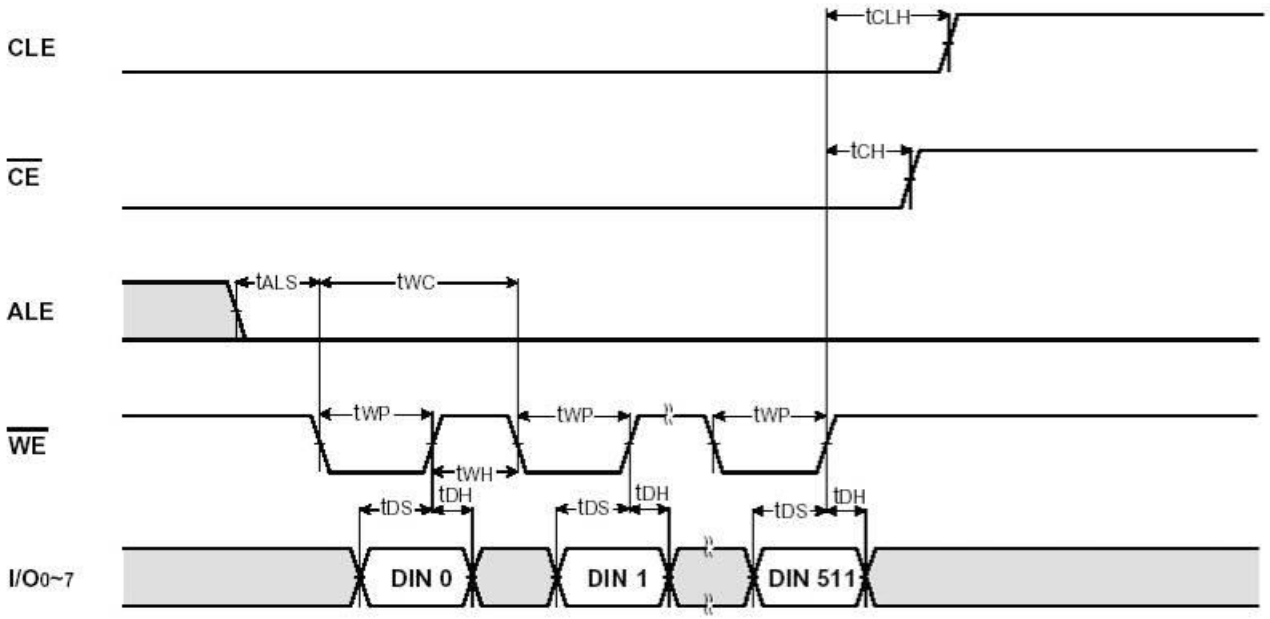


Figure 4-3 FxU3 I Input Data Latch Cycle

4.4.5. Sequential Out Cycle after Read (CLE=L, /WE=H, ALE=L)

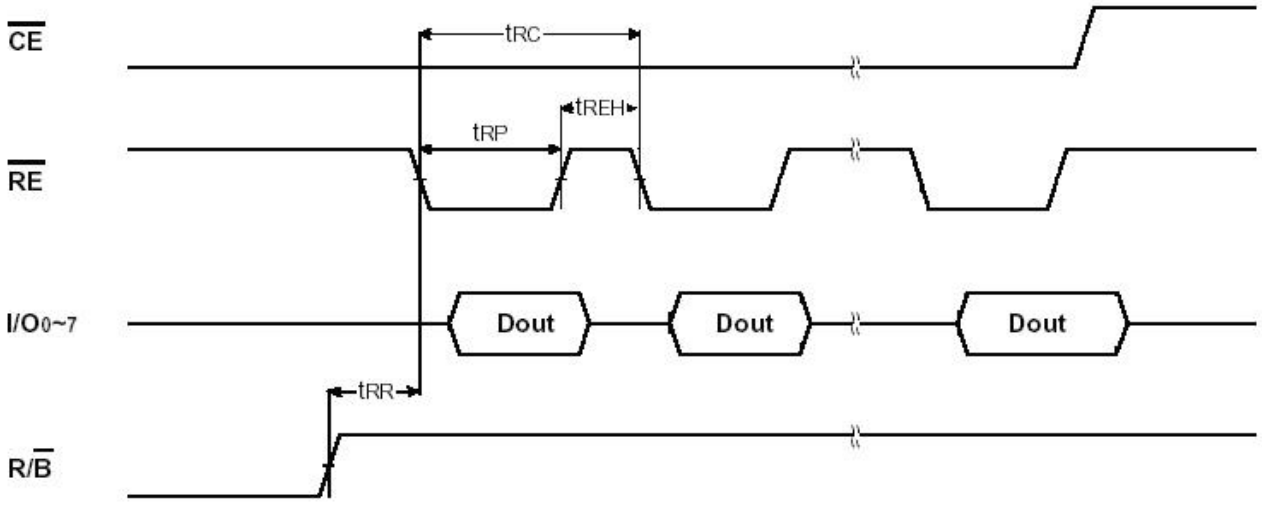
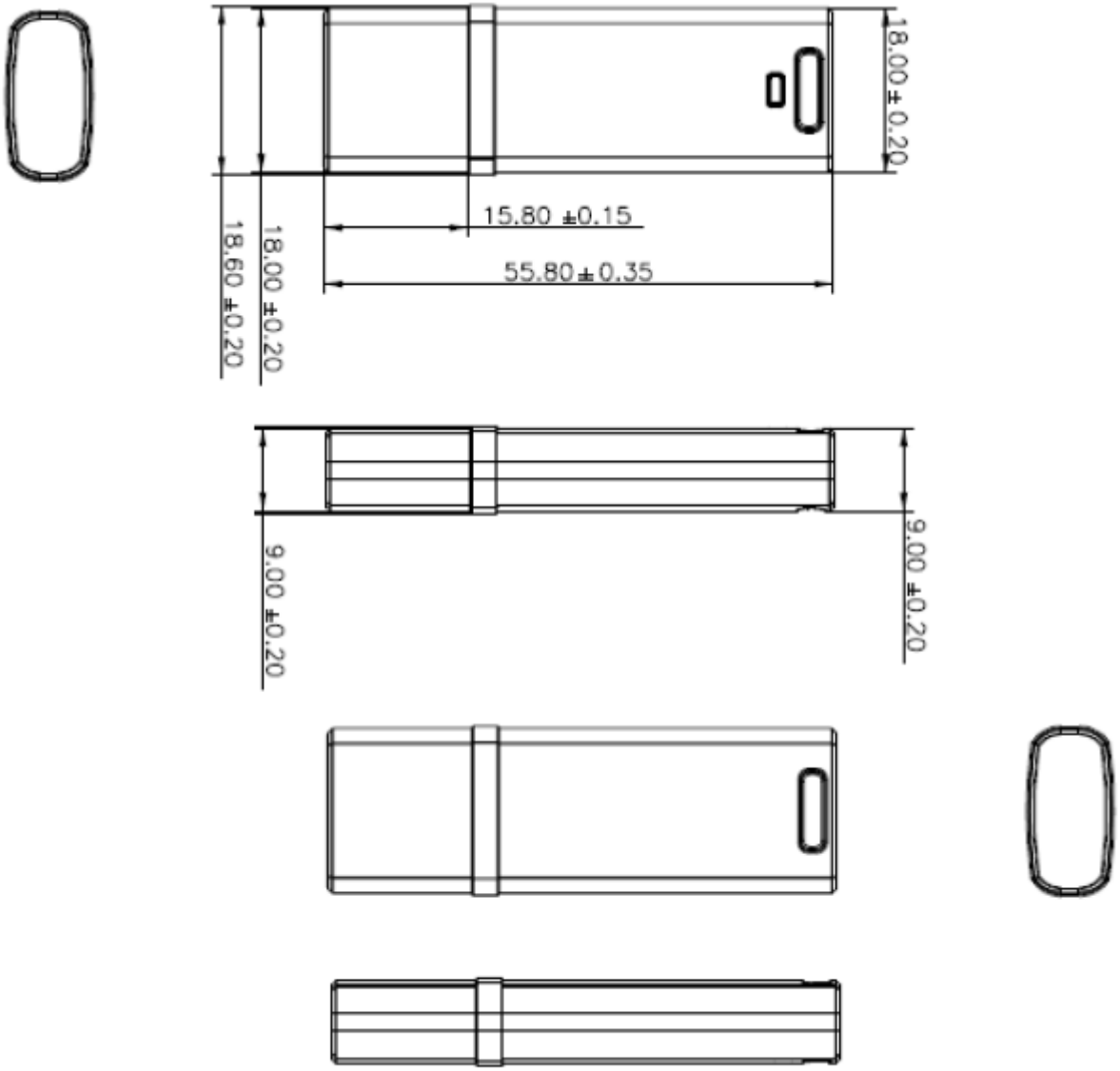


Figure 4-4 FxU3 I Sequential Out Cycle

5. PHYSICAL DIMENSION

Dimension: 55.8 (L) x 18.0 (W) x 9.0 (H) mm



6. ORDERING INFORMATION

Capacity	MPN (Silver)	MPN (Diamond)
4GB	FUUP004GTTS7-033-10	FUUP004GTTE7-033-10
8GB	FUUP008GTTS7-033-10	FUUP008GTTE7-033-10
16GB	FUUP016GTTS7-033-10	FUUP016GTTE7-033-10
32GB	FUUP032GTTS7-033-10	FUUP032GTTE7-033-10
64GB	FUUP064GTTS7-033-10	FUUP064GTTE7-033-10
128GB	FUUP128GTTS7-033-10	FUUP128GTTE7-033-10
256GB	FUUP256GTTS7-033-10	FUUP256GTTE7-033-10