## **Approval Sheet**

Customer	
Product Number	M2SK-2GMF6I05-M
Module speed	PC2-6400
Pin	200 Pin
CL-tRCD-tRP	5-5-5
SDRAM Operating Temp	-40°C ~ 85°C
Date	19 <sup>th</sup> December 2023

The Total Solution For Industrial Flash Storage innodisk

Rev 1.2

#### 1. Features

#### Key Parameter

Industry	D	Data Rate MT/s			tRP	tRC
Nomenclature	CL=3	CL=4	CL=5	(ns)	(ns)	(ns)
PC2-6400	400	533	800	12.5	12.5	57.5

- JEDEC Standard 200-pin Dual In-Line Memory Module
- Intend for 400MHz applications
- Inputs and Outputs are SSTL-18 compatible
- VDD=VDDQ= 1.8 Volt  $\pm$  0.1
- Differential clock input
- All inputs are sampled at the positive going edge of the system clock
- Bi-Directional data strobe with one clock cycle preamble and one-half clock post-amble
- Address and control signals are fully synchronous to positive clock edge.
- Auto Refresh (CBR) and Self Refresh Modes support.
- Serial Presence Detect with EEPROM

- Golden Connector (Au:30um)
- Automatic and controlled precharge commands.
- 14/10/2 Addressing (row/column/rank)-2GB
- Auto & self refresh 7.8µs (TC ≤ +85°C)
  Golden Contactor
- SDRAM Operation Temperature (Note 1)
  - -40°C ≤ Tc ≤ +85°C
- Programmable Device Operation:
  - Burst Type: Sequential or Inteleave
  - Operation: Burst Read and Write
  - Device CAS# Latency: 3,4,5
  - Burst Length: 4, 8

• RoHS Compliant (Section 15)

Note: 1. The refresh rate is required to double when Tc exceeds  $85^{\circ}$ C.

### 2. Environmental Requirements

iDIMM are intended for use in standard office environments that have limited capacity for

heating and air conditioning.

Symbol	Parameter	Rating	Units	Notes
Topr	Operating Temperature	-40 to +85	°C	3
Тѕтс	Storage Temperature	-50 to +100	°C	
Hopr	Operating Humidity (relative)	10 to 90	%	1
Нѕтс	Storage Humidity (without condensation)	5 to 95	%	1
PBAR	Barometric Pressure (operating & storage)	105 to 69	K Pascal	1,2

 Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only and device functional operation at or above the conditions indicated is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
 Up to 9850 ft.

3. The component maximum case temperature (Tcase) shall not exceed the value specified in the DDR2 DRAM component specification.

Rev 1.2



## 3. Ordering Information

DDR2 SODIMM								
Port Number	Donaity	Speed	Organization	Number of	Number	ECC		
Part Number	Density	Speed	Organization	DRAM	of rank			
M2SK-2GMF6I05-M	2GB	PC2-6400	256M x64	16	2	N/A		

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## 4. Pin Configurations (Front side/Back side)

#### -x64 SODIMM

Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back
1	VREF	101	A1	26	DM1	126	DQ37	51	DQS2	151	DQ42	76	DQ31	176	DQ55
2	Vss	102	A0	27	Vss	127	Vss	52	DM2	152	DQ46	77	Vss	177	Vss
3	Vss	103	VDD	28	Vss	128	Vss	53	Vss	153	DQ43	78	Vss	178	Vss
4	DQ4	104	VDD	29	/DQS1	129	/DQS4	54	Vss	154	DQ47	79	CKE0	179	DQ56
5	DQ0	105	A10/AP	30	CK0	130	DM4	55	DQ18	155	Vss	80	NC/CKE1	180	DQ60
6	DQ5	106	BA1	31	DQS1	131	DQS4	56	DQ22	156	Vss	81	VDD	181	DQ57
7	DQ1	107	BA0	32	/CK0	132	Vss	57	DQ19	157	DQ48	82	VDD	182	DQ61
8	Vss	108	/RAS	33	Vss	133	Vss	58	DQ23	158	DQ52	83	NC 2	183	Vss
9	Vss	109	/WE	34	Vss	134	DQ38	59	Vss	159	DQ49	84	NC 3	184	Vss
10	DM0	110	/S0	35	DQ10	135	DQ34	60	Vss	160	DQ53	85	NC 3	185	DM7
11	/DQS0	111	VDD	36	DQ14	136	DQ39	61	DQ24	161	Vss	86	NC 3	186	/DQS7
12	Vss	112	VDD	37	DQ11	137	DQ35	62	DQ28	162	Vss	87	VDD	187	Vss
13	DQS0	113	/CAS	38	DQ15	138	Vss	63	DQ25	163	NC,TEST	88	VDD	188	DQS7
14	DQ6	114	ODT0	39	Vss	139	Vss	64	DQ29	164	CK1	89	A12	189	DQ58
15	Vss	115	NC 4	40	Vss	140	DQ44	65	Vss	165	Vss	90	A11	190	Vss
16	DQ7	116	NC 4	41	Vss	141	DQ40	66	Vss	166	/CK1	91	A9	191	DQ59
17	DQ2	117	VDD	42	Vss	142	DQ45	67	DM3	167	/DQS6	92	A7	192	DQ62
18	Vss	118	VDD	43	DQ16	143	DQ41	68	/DQS3	168	Vss	93	A8	193	Vss
19	DQ3	119	NC 4	44	DQ20	144	Vss	69	NC 1	169	DQS6	94	A6	194	DQ63
20	DQ12	120	NC 4	45	DQ17	145	Vss	70	DQS3	170	DM6	95	VDD	195	SDA
21	Vss	121	Vss	46	DQ21	146	/DQS5	71	Vss	171	Vss	96	VDD	196	Vss
22	DQ13	122	Vss	47	Vss	147	DM5	72	Vss	172	Vss	97	A5	197	SCL
23	DQ8	123	DQ32	48	Vss	148	DQS5	73	DQ26	173	DQ50	98	A4	198	SA0
24	Vss	124	DQ36	49	/DQS2	149	Vss	74	DQ30	174	DQ54	99	A3	199	VDDSPD
25	DQ9	125	DQ33	50	/Event	150	Vss	75	DQ27	175	DQ51	100	A2	200	SA1
NO - N															

NC = No Connect, RFU = Reserved for Future Use 1. Pin69 is optional /Reset 2. Pin83 is optional /S2 3. Pin84(85 & 86) is optional /A15(/BA2 & A14) 3. Pin115(116, 119 & 120) is optional /S1(/A13, ODT1 & /S3)

### 5. Architecture

#### Pin Definition

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Pin Name	Description	Pin Name	Description
A0 - A13 (A14 or A15)	SDRAM address bus	CK0 - CK2 CK0# - CK2#	SDRAM Clocks
BA0 - BA1 (or BA2)	SDRAM Bank Address Inputs	SCL	Serial Presence Detect Clock Input
RAS#	SDRAM row address strobe	SDA	Serial Presence Detect Data input/output
CAS#	SDRAM column address strobe	SA0 – SA2	Serial Presence Detect Address Inputs
WE#	SDRAM write enable	Vdd	Power (1.8V)
S0# - S1#	DIMM Rank Select Lines	Vddq	SDRAM I/O Driver power supply
CK0 – CKE1	SDRAM clock enable lines	Vref	SDRAM I/O Reference supply
ODT0, ODT1	Active termination control lines	Vss	Ground
DQ0 – DQ63	DIMM memory data bus	Vddspd	Serial EEPROM positive power supply
CB0 – CB7	DIMM ECC check bit	NC	Spare Pin
DQS0 – DQS8 DQS0# - DQS8#	SDRAM data strobes	Reset	NOT use on UDIMM
DM0 – DM8	SDRAM data masks/high data strobe (x8 base x72 bit module use only)		

## 6. Input/Output Functional Description

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Symbol	Туре	Polarity	Function
CK0, CK1, CK2	(SSTL)	Positive Edge	The positive line of the differential pair of system clock inputs which drives the input to the on-DIMM PLL. All the DDR2 SDRAM address and control inputs are sampled on the rising edge of their associated clocks.
CK0#, CK1#, CK2#	(SSTL)	Negative Edge	The negative line of the differential pair of system clock inputs which drives the input to the on-DIMM PLL.
CKE0, CKE1	(SSTL)	Active High	Activates the SDRAM CK signal when high and deactivates the CK signal when low. By deactivating the clocks, CKE low initiates the Power Down mode, or the Self Refresh mode.
CKE0#, CKE1#	(SSTL)	Active Low	Enables the associated SDRAM command decoder when low and disables the command decoder when high. When the command decoder is disabled, new commands are ignored but previous operations continue.
RAS#, CAS#, WE#	(SSTL)	Active Low	When sampled at the positive rising edge of the clock, RAS#, CAS#, WE# define the operation to be executed by the SDRAM.
Vref	Supply		Reference voltage for SSTL-18 inputs
νασα	Supply		Isolated power supply for the DDR SDRAM output buffers to provide improved noise immunity
ODT0, ODT1	Input	Active High	On-Die Termination control signals
BA0, BA1	(SSTL)	-	Selects which SDRAM bank is to be active.
A0 – A9 A10/AP A11 – A13	(SSTL)	-	During a Bank Activate command cycle, A0-A14 defines the row address (RA0-RA13) when sampled at the rising clock edge. During a Read or Write command cycle, A0-A9 defines the column address (CA0-CA9) when sampled at the rising clock edge. In addition to the column address, AP is used to invoke Autoprecharge operation at the end of the Burst Read or Write cycle. If AP is high, autoprecharge is selected and BA0/BA1 define the bank to be precharged. If AP is low, autoprecharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA0/BA1 to control which bank(s) to precharge. If AP is high all 4 banks will be precharged regardless of the state of BA0/BA1. If AP is low, then BA0/BA1 are used to define which bank to pre-charge.
DQ0 – DQ63	(SSTL)	Active High	Data and Check Bit Input/Output pins.
Vdd, Vss	Supply		Power and ground for the DDR SDRAM input buffers and core logic

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DQS0 – DQS8 DQS0# – DQS8#	(SSTL)	Negative and Positive Edge	Data strobe for input and output data
DM0 – DM8	Input	Active High	The data write masks, associated with one data byte. In Write mode, DM operates as a byte mask by allowing input data to be written if it is low but blocks the write operation if it is high. In Read mode, DM lines have no effect.
SA0 – SA2	-	-	Address inputs. Connected to either $V_{DD}$ or $V_{SS}$ on the system board to configure the Serial Presence Detect EEPROM address.
SDA	-	-	This bi-directional pin is used to transfer data into or out of the SPD EEPROM. A resistor must be connected from the SDA bus line to V DD to act as a pull-up.
SCL	-	-	This signal is used to clock data into and out of the SPD EEPROM. A resistor may be connected from the SCL bus time to V DD to act as a pull-up.
VDDSPD	Supply	-	Serial EEPROM positive power supply.



### 7. Function Block Diagram:

- (2 Ranks, 128Mx8 DDR2 base SDRAM Module)



### **Absolute Maximum Ratings**

Symbol	Parameter	Rating	Units				
V <sub>IN</sub> , V <sub>OUT</sub>	Voltage on I/O pins relative to Vss	-0.5 to 2.3	V				
V <sub>DD</sub>	Voltage on VDD supply relative to Vss	-1.0 to +2.3	V				
V <sub>DDQ</sub>	Voltage on VDDQ supply relative to Vss	-0.5 to +2.3	V				
Note: Stresse	s greater than those listed under "Absolute Maximum Ratir	ngs" may cause permanent dama	age to the				
device. This is s	tress rating only, and functional operation of the device at	these or any other conditions abo	ove those				
indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating							
conditions for extended periods may affect reliability.							

### 8. AC & DC Operating Conditions

#### - AC Electrical Characteristics and Operating Conditions

 $(T_{CASE} = -40 \text{ °C} \sim 85 \text{ °C}; V_{DDQ} = 1.8V \pm 0.1V; V_{DD} = 1.8V \pm 0.1V)$ 

Symbol	Parameter	Value	Units	Notes
VREF	Input Reference Voltage	0.5 * VDDQ	V	1
VSWING (MAX)	Input signal maximum peak to peak swing	1.7	V	1
SLEW	Input signal minimum slew rate	0	V	2,3
VIH (AC)	Input High (Logic1) Voltage	Vref + 0.125	V	
VIL (AC)	Input Low (Logic0) Voltage	-0.3	V	

Note::

1. Input waveform timing is referenced to the input signal crossing through the VIH/IL(AC) level applied to the device under test.

2. The input signal minimum slew rate is to be maintained over the range from VREF to VIH(AC) min for rising edges

and the range from VREF to VIL(AC) max for falling edges as shown in the below figure.

3. AC timings are referenced with input waveforms switching from VIL(AC) to VIH(AC) on the positive transitions and

VIH(AC) to VIL(AC) on the negative transitions.

#### - SDRAM DC operating Conditions

Symbol	Parameter	Rating	Units	Note		
T <sub>CASE</sub>	Operating Temperature	-40 to 85	°C	1,2		
Note:						
1. Cas	Case temperature is measured at top and center side of any DRAMs.					
2. tcas	tcase > 85°C → treFi = 3.9 μs All DRAM specification only support -40°C < tcase < 85°C					

#### - DC Electrical Characteristics and Operating Conditions

#### $(T_{CASE} = -40 \text{ °C} \sim 85 \text{ °C}; V_{DDQ} = 1.8V \pm 0.1V; V_{DD} = 1.8V \pm 0.1V)$

Symbol	Parameter	Min	Мах	Units	Notes
Vdd	Supply Voltage	1.7	1.9	V	1
VDDL	Supply Voltage for DLL	1.7	1.9	V	1
VDDQ	I/O Supply Voltage	1.7	1.9	V	1
VREF	I/O Reference Voltage	0.49Vddq	0.51Vddq	V	1, 2
Vtt	Termination Voltage	VREF-0.04	Vref+0.04	V	31
VIH (DC)	Input High (Logic1) Voltage	Vref + 0.125	Vddq + 0.3	V	1
VIL (DC)	Input Low (Logic0) Voltage	-0.3	Vref - 0.125	V	1

#### Note:

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1. Inputs are not recognized as valid until VREF stabilizes.

2. VREF is expected to be equal to 0.5 V DDQ of the transmitting device, and to track variations in the DC level of the

same. Peak-to-peak noise on VREF may not exceed 2% of the DC value.

. VTT of transmitting device must track VREF of receiving device.

### 9. Operating, Standby, and Refresh Currents

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- 2GB SODIMM (2Ranks, 128Mx8 DDR2 SDRAMs  $T_{CASE}$  = -40 °C ~ 85 °C;  $V_{DDQ}$  =  $V_{DD}$  = 1.8V ± 0.1V)

Symbol	Parameter/Condition	PC2-6400	Unit
I DD0	Operating Current: one bank; active/precharge; tRC = tRC (MIN); tCK = tCK (MIN); DQ, DM, and DQS inputs changing twice per clock cycle; address and control inputs changing once per clock cycle	1040	mA
I dd1	Operating Current: one bank; active/read/precharge; Burst = 2; tRC = tRC (MIN); CL=2.5; tCK = tCK (MIN); IOUT = 0mA; address and control inputs changing once per clock cycle	1200	mA
I dd2p	Precharge Power-Down Standby Current: all banks idle; power-down mode; CKE $\leq$ VIL (MAX); tCK = tCK (MIN)	160	mA
I dd2n	Idle Standby Current: $CS \ge VIH$ (MIN); all banks idle; $CKE \ge VIH$ (MIN); $tCK = tCK$ (MIN); address and control inputs changing once per clock cycle	448	mA
I dd2q	Precharge Quiet Standby Current: All banks idle; is HIGH; CKE is HIGH; $t_{CK} = t_{CK (MIN)}$ ; Other control and address inputs are stable, Data bus inputs are floating.	384	mA
I DD3PF	Active Power-Down Current: All banks open; tCK = tCK (MIN), CKE is LOW; Other control and address inputs are STABLE, Data bus inputs are floating. MRS A12 bit is set to <b>low</b> (Fast Power-down Exit).	480	mA
I DD3PS	Active Power-Down Current: All banks open; tCK = tCK (MIN), CKE is LOW; Other control and address inputs are STABLE, Data bus inputs are floating. MRS A12 bit is set to <b>high</b> (Slow Power-down Exit).	320	mA
I dd3n	Active Standby Current: one bank; active/precharge; $CS \ge VIH$ (MIN); $CKE \ge VIH$ (MIN); $tRC = tRAS$ (MAX); $tCK = tCK$ (MIN); DQ, DM, and DQS inputs changing twice per clock cycle; address and control inputs changing once per clock cycle	528	mA
I dd4w	Operating Current: one bank; Burst = 2; writes; continuous burst; address and control inputs changing once per clock cycle; DQ and DQS inputs changing twice per clock cycle; CL=2.5; tCK = tCK (MIN)	2000	mA
I dd4r	Operating Current: one bank; Burst = 2; reads; continuous burst; address and control inputs changing once per clock cycle; DQ and DQS outputs changing twice per clock cycle; CL = 2.5; tCK = tCK (MIN); IOUT = 0mA	1920	mA
I dd5	Auto-Refresh Current: tRC = tRFC (MIN)	2480	mA
I DD6	Self-Refresh Current: CKE $\leq$ 0.2V	112	mA
I dd7	Operating Current: four bank; four bank interleaving with $BL = 4$ , address and control inputs randomly changing; 50% of data changing at every transfer; tRC = tRC (min); IOUT = 0mA.	3360	mA

## 10. AC Timing Specifications

(T<sub>CASE</sub> = -40 °C ~ 85 °C; V<sub>DDQ</sub> = 1.8V  $\pm$  0.1V; V<sub>DD</sub> = 1.8V  $\pm$  0.1V, See AC Characteristics)

Complete	Denemation	PC2-6400		Unit
Symbol	Parameter	Min.	Max.	
tAC	DQ output access time from CK/CK#	-0.40	+0.40	ns
<b>t</b> DQSCK	DQS output access time from CK/CK#	-0.35	+0.35	ns
tCH	CK high-level width	0.45	0.55	tСK
tCL	CK low-level width	0.45	0.55	tСK
tHP	Minimum half clk period for any given cycle; defined by clk high (tCн) or clk low (tCL) time	tCH or tCL	-	tСK
tСK	Clock Cycle Time	2.5	8	ns
tDS	DQ and DM input setup time(differential data strobe)	0.05	-	ns
tDH	DQ and DM input hold time(differential data strobe)	0.125	-	ns
tIPW	Input pulse width	0.6	-	tСK
tDIPW	DQ and DM input pulse width (each input)	0.35	-	tСK
tHZ	Data-out high-impedance time from CK/XK	-	tACmax	ns
tLZ(DQS)	DQS low-impedance time from CK/XK	tACmin	tACmax	ns
tLZ(DQ)	DQ low-impedance time from CK/XK	2t <sub>AC</sub> min	t <sub>AC</sub> max	ns
tDQSQ	DQS-DQ skew (DQS & associated DQ signals)	-	0.20	ns
tQHS	Data hold Skew Factor	-	0.30	ns
tQH	Data output hold time from DQS	thp — tqhs	-	ns
tDQSS	Write command to 1 <sup>st</sup> DQS latching transition	-0.25	+0.25	tСK
tDQSL,(H)	DQS input low (high) pulse width (write cycle)	0.35	-	tСK
tDSS	DQS falling edge to CK setup time (write cycle)	0.2	-	tСK
tDSH	DQS falling edge hold time from CK (write cycle)	0.2	-	tСК
tMRD	Mode register set command cycle time	2	-	tСK

tWPST	Write postamble	0.40 0.60		tск
tWPRE	Write preamble	0.35 -		tск
tін	Address and control input hold time	250 -		Ps
tis	Address and control input setup time 175 -		-	Ps
tRPRE	Read preamble	0.90	1.10	tCK
tRPST	Read postamble	0.40	0.60	tCK
tRRD	Active bank A to Active bank B command	7.5 -		Ns
tDelay	Minimum time clocks remains ON after CKE asynchronously drops Low	tIS + tCK + tIH		Ns
tREFI	Average Periodic Refresh Interval (85ºC < T <sub>CASE</sub> ≤ 95ºC)	3.9		Ms
	Average Periodic Refresh Interval (0ºC ≤ T <sub>CASE</sub> ≤ 85ºC)	7.8		Ms
toit	OCD drive mode output delay	0 12		Ns
tCCD	CAS# to CAS# delay	2		tCK
tWR	Write recovery time without Auto-Precharge	15	-	Ns
WR	Write recovery time with Auto-Precharge	tWR/tCK	-	tCK
tDAL	Auto precharge write recovery + precharge time	WR+tRP	-	tCK
tWTR	Internal write to read command delay 7.5 -		-	Ns
tRTP	Internal read to precharge command delay 7.5			Ns
<b>t</b> XSNR	Exit self refresh to a Non-read command tRFC+10			Ns
txsrd	Exit self refresh to a Read command 200			tСK
tXP	Exit precharge power down to any Non- read command	2	-	tск
txard	Exit active power down to read command	2	-	tСK
txards	Exit active power down to read command	8-AL		tСK
tCKE	CKE minimum pulse width	3		tСK

Symbol	Parameter	PC2-6400		11-14
		Min.	Max.	Unit
taond	ODT turn-on delay	2	2	tCK
taon	ODT turn-on	tAC (min)	tAC (max) +0.7	Ns
taonpd	ODT turn-on (Power down mode)	tAC (min) +2	2tCK + tAC(max) +1	Ns
taofd	ODT turn-off delay	2.5	2.5	tCK
taof	ODT turn-off	tAC(min)	tAC(max) +0.6	Ns
taofpd	ODT turn-off (Power down mode)	tAC (min)+2	2.5tCK + tAC(max) +1	Ns
tANPD	ODT to power down entry latency	3		tCK
tAXPD	ODT power down exit latency	8		tСK

## 11. Speed Grade Definition

Symbol	Devenueter	PC2-	11	
Symbol	Parameter	Min	Max	Unit
tRAS	Row Active Time	40	70,000	ns
tRC	Row Cycle Time	57.5	-	ns
tRCD	RAS to CAS delay	12.5	-	ns
tRP	Row Precharge Time	12.5	-	ns

## 12. Physical Dimension



### **13. RoHS Declaration**

P				
innodisk 官鼎圖際股份有限公司				
	且用國际成仍有限公司			
Innodis	k Corporation			
	Tel:(02)7703-3000 Fax:(02) 7703-3555 Internet: http://www.innodisk.com/			
RoHS 自我宣告書(	(RoHS Declaration of Conformity)			
Manufacturer Product: All In	nnodisk EM Flash and Dram products			
<ul> <li>一、 宣鼎國際股份有限公司(以下稱本公司 2011/65/EU 關於 RoHS 之規範要求。</li> </ul>	)特此保證售予費公司之所有產品,皆符合歐盟			
Innodisk Corporation declares that a European Union RoHS Directive (201	all products sold to the company, are complied with 1/65/EU) requirement			
二、 本公司同意因本保證書或與本保證書相	關事宣有所爭議時,雙方宜友好協商,違成協議。			
Innodisk Corporation agrees that be	oth parties shall settle any dispute arising f <b>ro</b> m			
or in connection with this Declara	tion of Conformity by friendly negotiations.			
Name of hazardous substance	Limited of RoHS ppm (mg/kg)			
Cd	< 100 ppm			
РЪ	< 1000 ppm			
Hg	< 1000 ppm			
Chromium VI (Cr+6)	< 1000 ppm			
Polybromodiphenyl ether (PBDE)	< 1000 ppm			
Polybrominated Biphenyls (PBB)	< 1000 ppm			
<b>立保證</b> Company name 公司名稱: <u>Innodisk Corporati</u> Company Representative 公司代表人: <u>Richar</u> Company Representative Title 公司代表人職稱: Date 日期: <u>2014 / 07 / 29</u>	<ul> <li>人 (Guarantor)</li> <li>ion 宜鼎國際股份有限公司</li> <li>rd Lee 李鐘亮</li> <li>: CEO 執行長</li> </ul>			
	(Company Stamp/公司大小章)			

## **Revision Log**

Rev	Date	Modification
0.1	16 <sup>th</sup> February 2016	Preliminary Edition
1.0	16 <sup>th</sup> February 2016	Official Release
1.1	15 <sup>th</sup> November 2023	Modified typo T_{CASE} = 0 °C ~ 85 °C to T_{CASE} = -40 °C ~ 85 °C
1.2	19 <sup>th</sup> December 2023	Modified typo Key Parameter