富鼎先進電子股份有限公司
ADVANCED POWER ELECTRONICS CORP.

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R.O.C.Tel:886-3-6215899 Fax:886-3-6215999
E-mail:mail@a-power.com.tw

承 認 書

Specification Sheet

Customer：海創科技有限公司

Customer Part Number	**AP4439GM-HF**
APEC Part Number	**AP4439GM-HF**
Issued Date	**2015/05/13**
SPEC No.	**SPEC-201505-0014**

APEC Approved		
Sales Manager	**Sales**	**QA**

Customer Approved			
Dept.			
Signature			

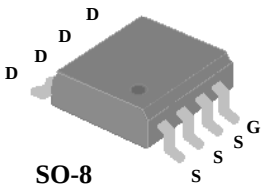
AP4439GM-HF

Halogen-Free Product

Advanced Power Electronics Corp.

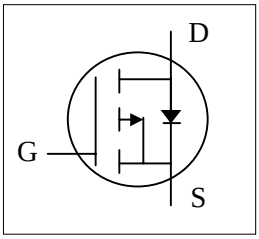
P-CHANNEL ENHANCEMENT MODE POWER MOSFET

- ▼ **Simple Drive Requirement**
- ▼ **Lower On-resistance**
- ▼ **Fast Switching Characteristic**
- ▼ **RoHS Compliant & Halogen-Free**



SO-8

BV_{DSS}	-30V
$R_{DS(ON)}$	10mΩ
I_D	-13.3A



Description

Advanced Power MOSFETs from APEC provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The SO-8 package is widely preferred for all commercial-industrial surface mount applications and suited for low voltage applications such as DC/DC converters.

Absolute Maximum Ratings@T_j=25°C(unless otherwise specified)

Symbol	Parameter	Rating	Units
V_{DS}	Drain-Source Voltage	-30	V
V_{GS}	Gate-Source Voltage	±25	V
I_D@T_A=25℃	Drain Current[3], V_{GS} @ 10V	-13.3	A
I_D@T_A=70℃	Drain Current[3], V_{GS} @ 10V	-10.6	A
I_{DM}	Pulsed Drain Current[1]	-50	A
P_D@T_A=25℃	Total Power Dissipation	2.5	W
T_{STG}	Storage Temperature Range	-55 to 150	℃
T_J	Operating Junction Temperature Range	-55 to 150	℃

Thermal Data

Symbol	Parameter	Value	Unit
Rthj-a	Maximum Thermal Resistance, Junction-ambient[3]	50	℃/W

Electrical Characteristics@T_j=25°C(unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V, I_D=-250uA	-30	-	-	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance[2]	V_{GS}=-10V, I_D=-12A	-	8	10	mΩ
		V_{GS}=-4.5V, I_D=-8A	-	12	17	mΩ
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS}, I_D=-250uA	-1	-	-3	V
g_{fs}	Forward Transconductance	V_{DS}=-10V, I_D=-12A	-	32	-	S
I_{DSS}	Drain-Source Leakage Current	V_{DS}=-24V, V_{GS}=0V	-	-	-30	uA
I_{GSS}	Gate-Source Leakage	V_{GS}=±20V, V_{DS}=0V	-	-	±100	nA
Q_g	Total Gate Charge	I_D=-12A	-	31	70	nC
Q_{gs}	Gate-Source Charge	V_{DS}=-15V	-	6.5	-	nC
Q_{gd}	Gate-Drain ("Miller") Charge	V_{GS}=-4.5V	-	14.5	-	nC
$t_{d(on)}$	Turn-on Delay Time	V_{DS}=-15V	-	9	-	ns
t_r	Rise Time	I_D=-1A	-	7	-	ns
$t_{d(off)}$	Turn-off Delay Time	R_G=3.3Ω	-	100	-	ns
t_f	Fall Time	V_{GS}=-10V	-	63	-	ns
C_{iss}	Input Capacitance	V_{GS}=0V	-	2770	5080	pF
C_{oss}	Output Capacitance	V_{DS}=-25V	-	420	-	pF
C_{rss}	Reverse Transfer Capacitance	f=1.0MHz	-	375	-	pF
R_g	Gate Resistance	f=1.0MHz	-	5	-	Ω

Source-Drain Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
V_{SD}	Forward On Voltage[2]	I_S=-2A, V_{GS}=0V	-	-	-1.2	V
t_{rr}	Reverse Recovery Time	I_S=-12A, V_{GS}=0V,	-	31	-	ns
Q_{rr}	Reverse Recovery Charge	dI/dt=100A/μs	-	23	-	nC

Notes:

1.Pulse width limited by Max. junction temperature.

2.Pulse test

3.Surface mounted on 1 in^2 copper pad of FR4 board, t ≤ 10s ; 125 ℃/W when mounted on Min. copper pad.

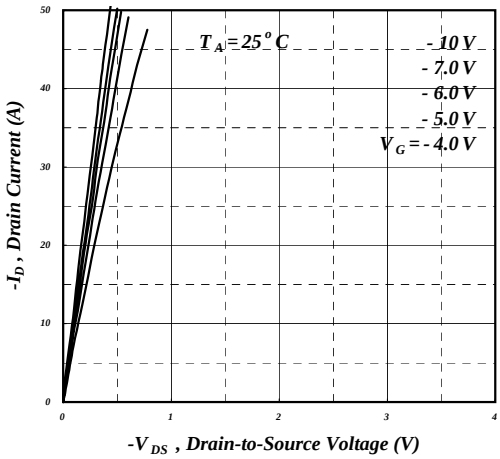


Fig 1. Typical Output Characteristics

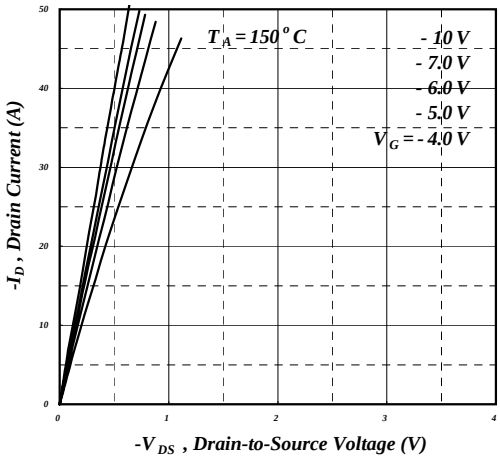


Fig 2. Typical Output Characteristics

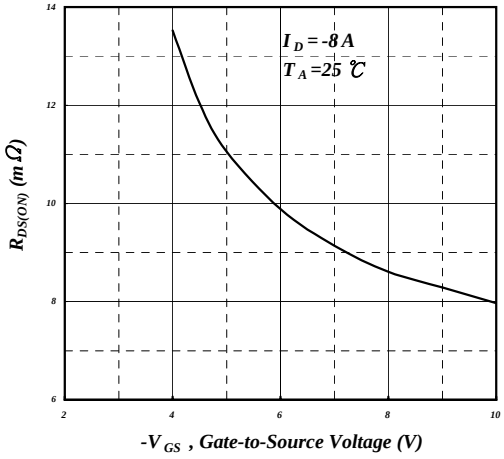


Fig 3. On-Resistance v.s. Gate Voltage

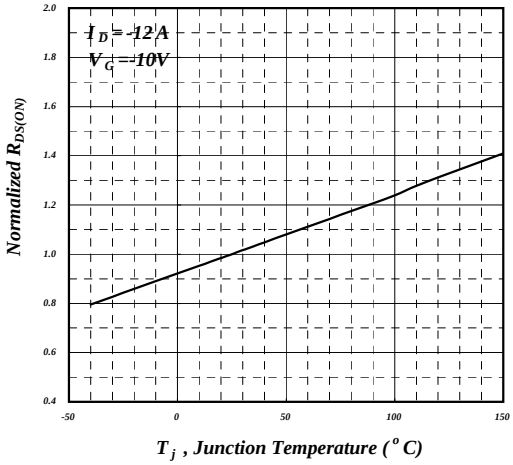


Fig 4. Normalized On-Resistance v.s. Junction Temperature

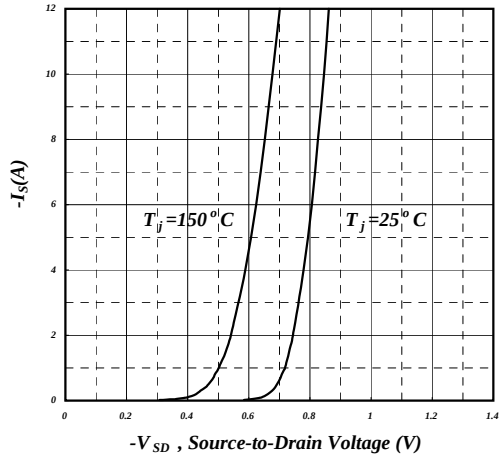


Fig 5. Forward Characteristic of Reverse Diode

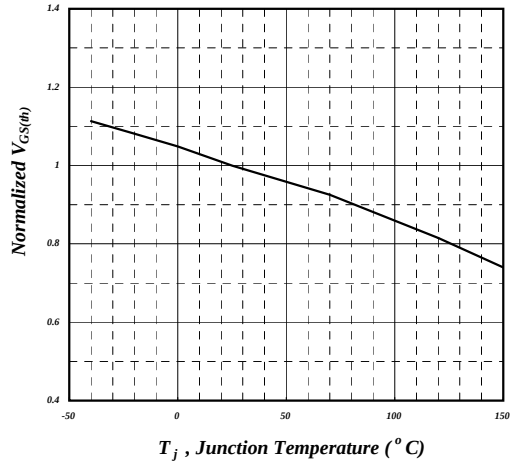


Fig 6. Gate Threshold Voltage v.s. Junction Temperature

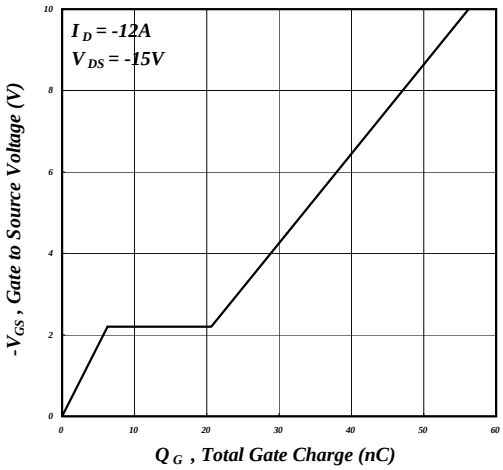


Fig 7. Gate Charge Characteristics

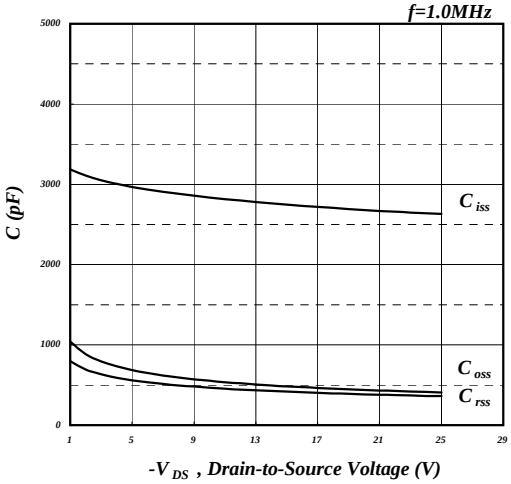


Fig 8. Typical Capacitance Characteristics

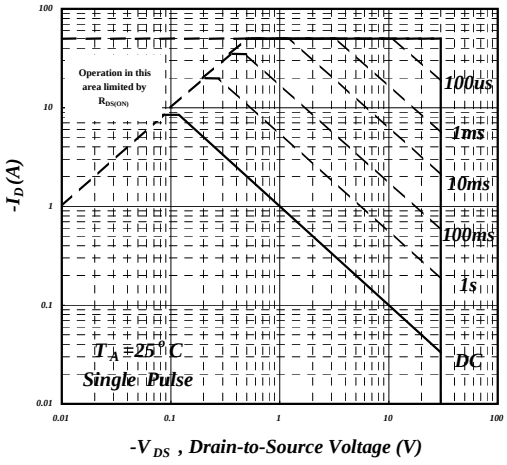


Fig 9. Maximum Safe Operating Area

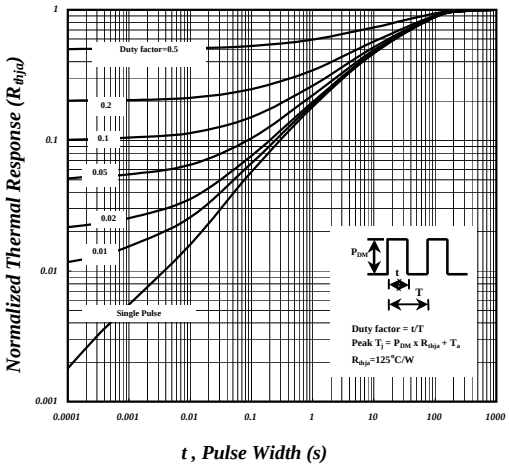


Fig 10. Effective Transient Thermal Impedance

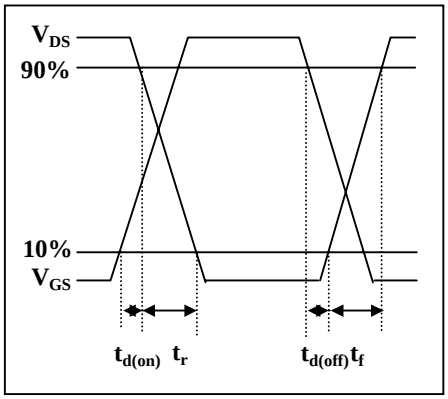


Fig 11. Switching Time Waveform

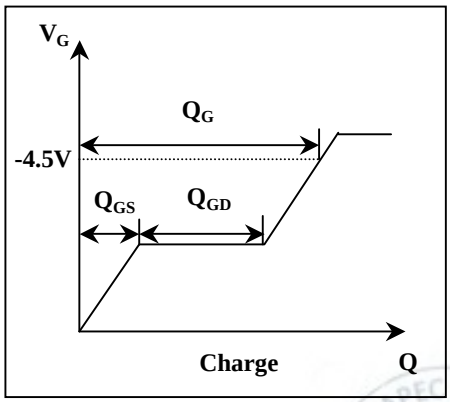
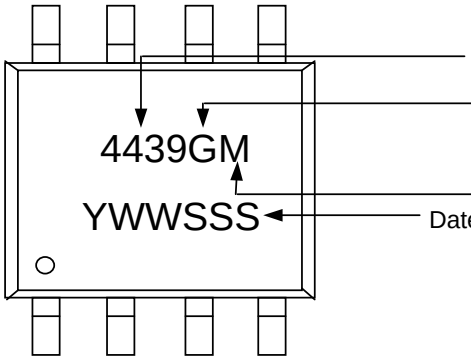


Fig 12. Gate Charge Waveform

MARKING INFORMATION



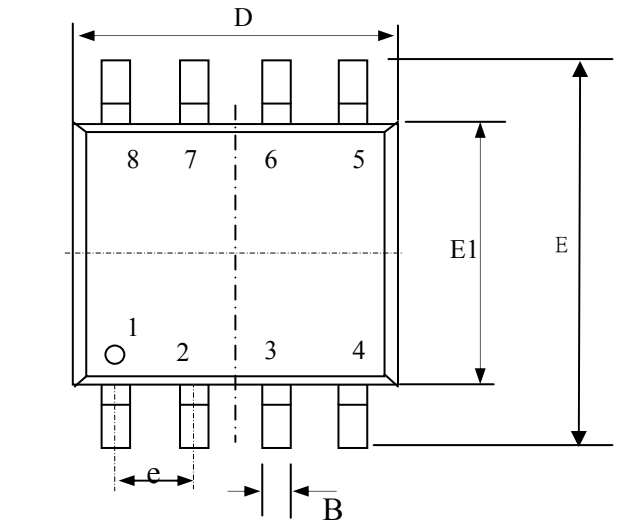
Part Number

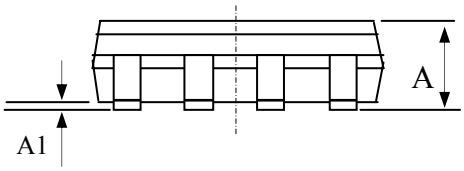
meet Rohs requirement
for low voltage MOSFET only

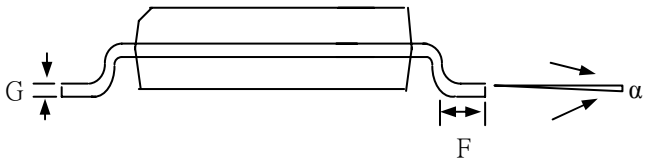
Package Code

Date Code (YWWSSS)
Y：Last Digit Of The Year
WW：Week
SSS：Sequence

Package Outline : SO-8







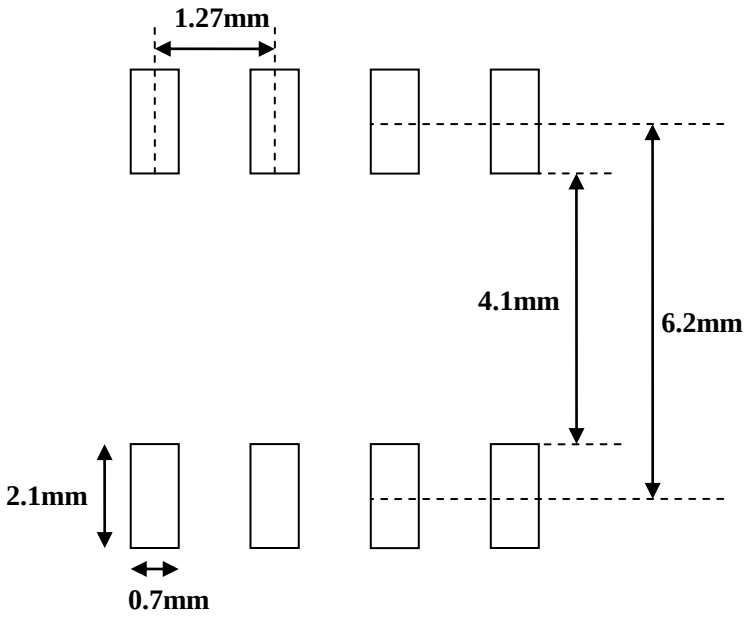
SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.05	0.15	0.25
B	0.30	0.41	0.51
D	4.80	5.05	5.30
E	5.79	6.00	6.20
E1	3.70	3.90	4.10
e	1.27 TYP		
G	0.17	0.21	0.25
F	0.38	0.83	1.27
α	0°	4°	8°

1.All Dimension Are In Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Draw No. M1-M8-G-v03

SO-8 FOOTPRINT：



富鼎先進電子股份有限公司

包裝規範

(5.1.5 USE BUBLE PLASTIC MATERIAL INSIDE THE CARTON THEN PUT THE WAFER BOX ONTO CARTON. AS ATTACHMENT 十一-3)

5.2 PACKAGE 產品包裝作業規定(5.2 PACKAGED FG PACKING STANDARD.)

5.2.1 管條(TUBE)之裝箱法(5.2.1 TUBE PACKING STANDARD.)

5.2.1.1

PKG TYPE	TO-220	TO-220CFM	TO-262	DIP-8	TO-3P	TO-251	TO-247
TUBE	50ea	50ea	50ea	50ea	30ea	80ea	30ea
INNER BOX	1000ea/Box	1000ea/Box	1000ea/Box	3000ea/Box	360ea/Box	8000ea/Box	240ea/Box
OUTER CORTON	6000ea/carton	6000ea/carton	6000ea/carton	12000ea/carton	1440ea/carton	40000ea/carton	1200ea/carton
CARTON DIMENSION	Attachment (一)	Attachment(一) Attachment (一-1)	Attachment (一)	Attachment (五)	Attachment (七)	Attachment(四)	Attachment (十二)

5.2.1.2 尾數箱裝箱時需將剩餘空間，以小內盒或氣泡膠填充之。

(5.2.1.2 NEED TO PUT EMPTY INNER BOX INSIDE OUTER CARTON FOR NON FULL PACKED CARTON.)

5.2.2 捲型包裝(TAPE&REEL)之裝箱法

(5.2.2 TAPE & REEL PECKING STANDARD.)

5.2.2.1

PKG TYPE	TO-252/ SOT-223	TO-263	SO-8/TSSOP-8/ ESOP-8/ PMPAK/ MESOP-8/ MESOP-10 DFN 3×3	SOT-23/5/6/ SOT-323/363 SC70-4L/5L/ TSOT-23/5/6 DNF 3×2/ DFN 2×2	SOT-89	GEM2928-8	TO-92
REEL	3000ea	800ea	3000ea	3000ea	1000ea	3000ea	2000ea
INNER BOX	6000ea/Box	800ea/box	6000ea/box	15000ea/box	4000ea/box	15000ea/box	2000ea/box
OUTER CORTON	24000ea/carton	4000ea/carton	48000ea/carton	150000ea/carton	40000ea/carton	150000ea/box	32000ea/box
CARTON DIMENSION	Attachment (二)	Attachment (二)	Attachment (三)	Attachment (二)	Attachment (二)	Attachment (二)	Attachment (八)
REEL SPEC.	Figure 一/六	Figure 三	Figure 二/八/十一	Figure 四/十/十二/十三/十四	Figure 五	Figure 七	Figure 九

5.2.2.2 尾數箱裝箱時需將剩餘空間，以小內盒或氣泡膠填充之。

(5.2.2.2 NEED TO PUT EMPTY IN'NER BOX OUTER CARTON FOR NON FULL PACKED CARTON.)

5.2.2.3 單一料捲只允許二個不同 DATA CODE 併捲。

(5.2.2.3 Only allow 2 different date code to be combined into one reel.)

5.2.3 靜電袋之裝箱法(5.2.3 BAG PACKING STANDARD.)

PKG TYPE	TO-220	TO-251/TO-92
BAG	50ea	100ea
INNER BOX	500ea/box	10000ea/box
OUTER CORTON	4000ea/carton	40000ea/carton
CARTON DIMENSION	Attachment (六)	Attachment (八)

5.2.3.2 尾數箱裝箱時需將剩餘空間，以小內盒氣泡膠填充之。

(5.2.3.2 NEED TO PUT EMPEY INNER BOX INSIDE OUTER CARTON FOR NON FULL PACKED CARTON.)

5.3 不同產品不可裝入同一箱子內，以避免產品混料。

(5.3 NO ANY DIFFERENT P/N FG INSIDE SAME CARTON.)

5.4 包裝箱標籤：整貨裝箱後將型號數量標籤(如附件七)貼在紙箱及小內盒側面。

(5.4 LABELING：ATTACH LABEL ONTO INNER BOX & OUTER CARTON AS ATTAHMENT 七.)

5.5 真空包裝：產品料卷放入抗靜電鋁箔袋中，同乾燥劑及濕度指示卡一起抽真空後，再置入內盒(Pizza Box)

5.5.1.真空包裝之裝箱法：

PKG TYPE	TO-252/ SOT-223	TO-263	SO-8/TSSOP-8/ ESOP-8/PMPAK/ MESOP-8/MESOP-10 DFN 3×3	SOT-23/25/26 SOT-323/363 SC70-4L/5L TSOT-23/5/6 DNF 3×2/ DFN 2×2	SOT-89	GEM2928-8
REEL	3000ea	800ea	3000ea	3000ea	1000ea	3000ea
INNER BOX	6000ea/Box	800ea/box	6000ea/box	12000ea/box	3000ea/box	15000ea/box
OUTER CORTON	24000ea/carton	4000ea/carton	48000ea/carton	120000ea/carton	30000ea/carton	150000ea/box
CARTON DIMENSION	Attachment (二)	Attachment (二)	Attachment (三)	Attachment (二)	Attachment (二)	Attachment(二)
REEL SPEC.	Figure 一/六	Figure 三	Figure 二/八/十一	Figure 四/十/十二 /十三/十四	Figure 五	Figure 七

5.5.2. 7 吋料卷如附件(九)

5.2.3. 13 吋料卷如附件(十)

*以上依客戶需求使用之。

5.6 包裝檢驗：裝箱完成後通知 QA 檢驗，檢驗合格則蓋上檢查合格章後等待出貨。

(5.6 PACKING INSPECTION：STAMP QA IN SPETION ONTO LABEL AFTER COMPLETELY PACKING STEP.)

6.外購成品的包裝規範依客戶要求。

(6. THE PACKING SPEC. OF PURCHASED FG IS FOLLOWED BY CUSTOMER'S REQUIREMENT.)

7. 相關文件：無

(7. DOCUMENT：NO)

附件七：外箱標籤（ *CARTON LABEL* ）

檢驗合格標章樣式：

有鉛產品標籤(For Pb-Sn Product) ：

富鼎先進電子股份有限公司
ADVANCED POWER ELECTRONICS CORP.

P/N：

DateCode：

QC： 檢查合格

Q'TY

富鼎先進電子股份有限公司
包裝規範

無鉛產品標籤(For Pb Free Product) ：

2014年13週以前開立的工單

2014年14週以後開立的工單

無鹵產品標籤(For Halogen Free Product) ：

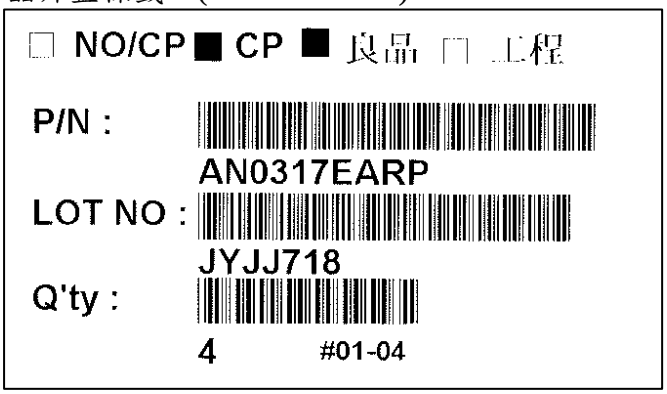
2014年13週以前開立的工單

2014年14週以後開立的工單

貼於產品標籤面右上角：

G. P. PASS

晶片盒標籤：(For Wafer Box)

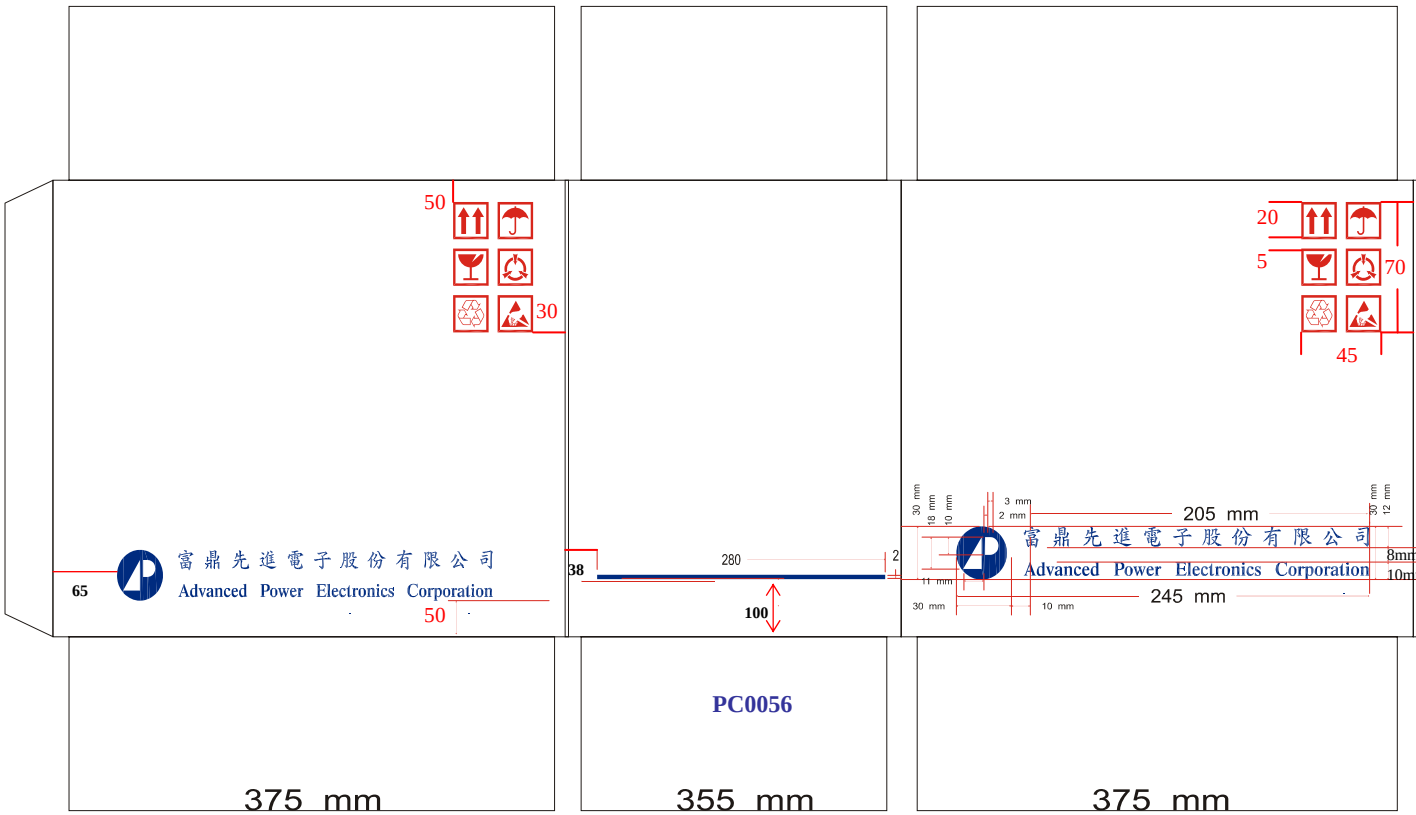


文件編號：QWMPC-7801
版　　別：40
頁　　碼：5

富鼎先進電子股份有限公司

包裝規範

Attachment 3：SO-8 、ESOP-8 、TSSOP-8、PMPAK、MESOP-8、MESOP-10 、DFN 3×3 Carton

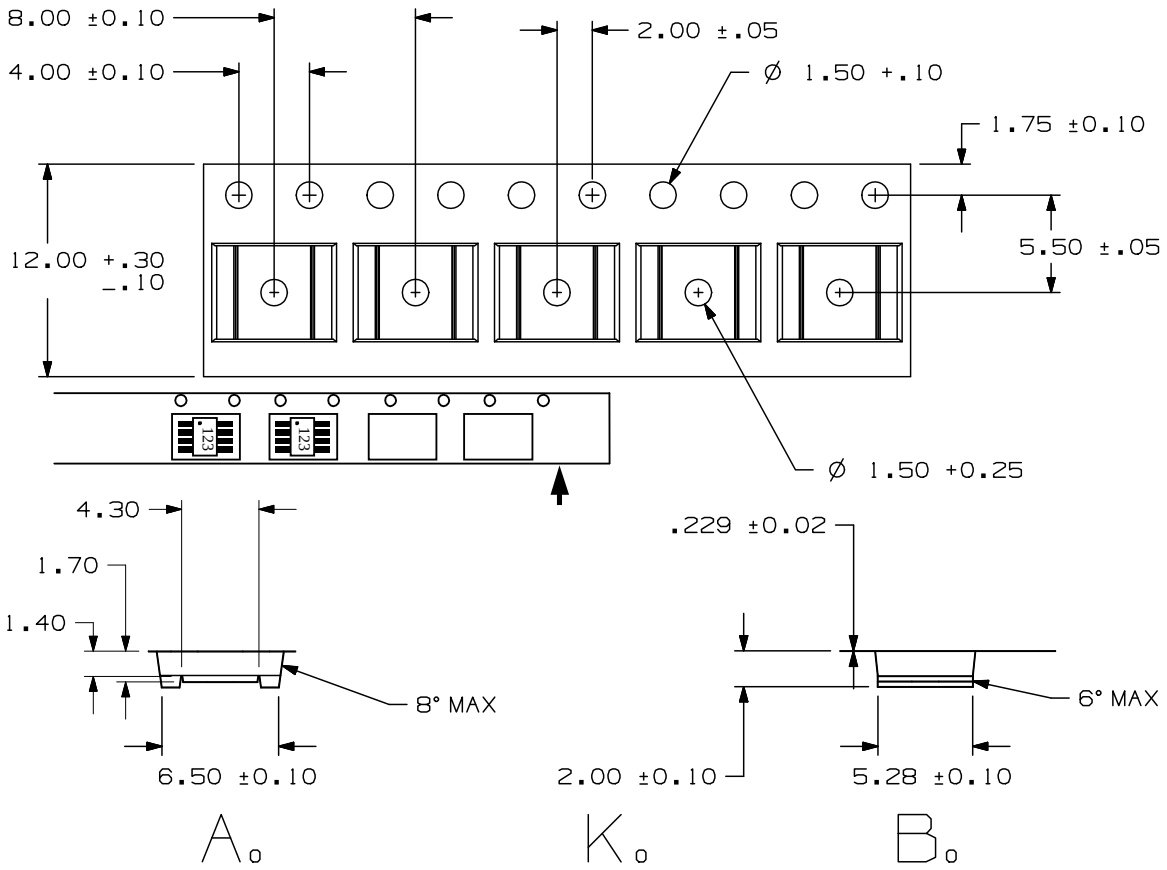


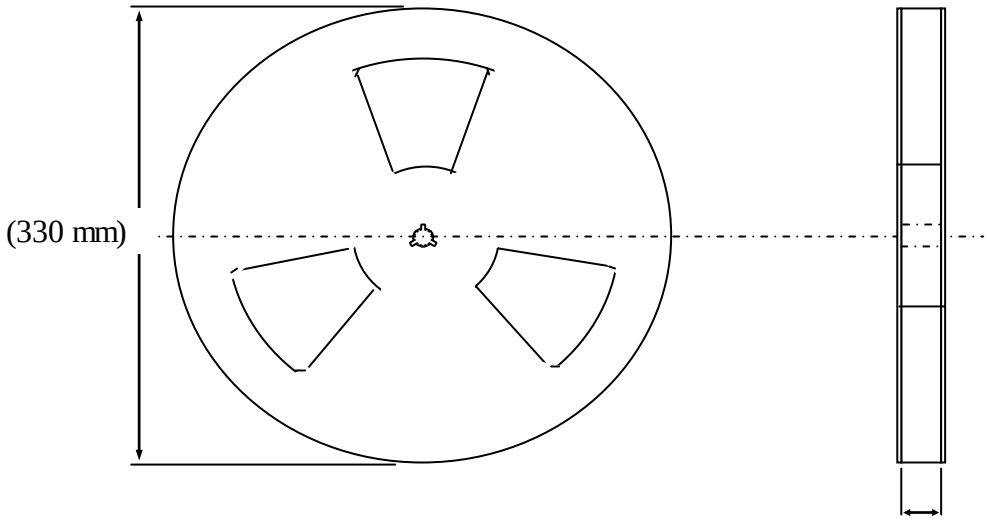
文件編號：QWMPC-7801
版　　別：40
頁　　碼：9

富鼎先進電子股份有限公司

包裝規範

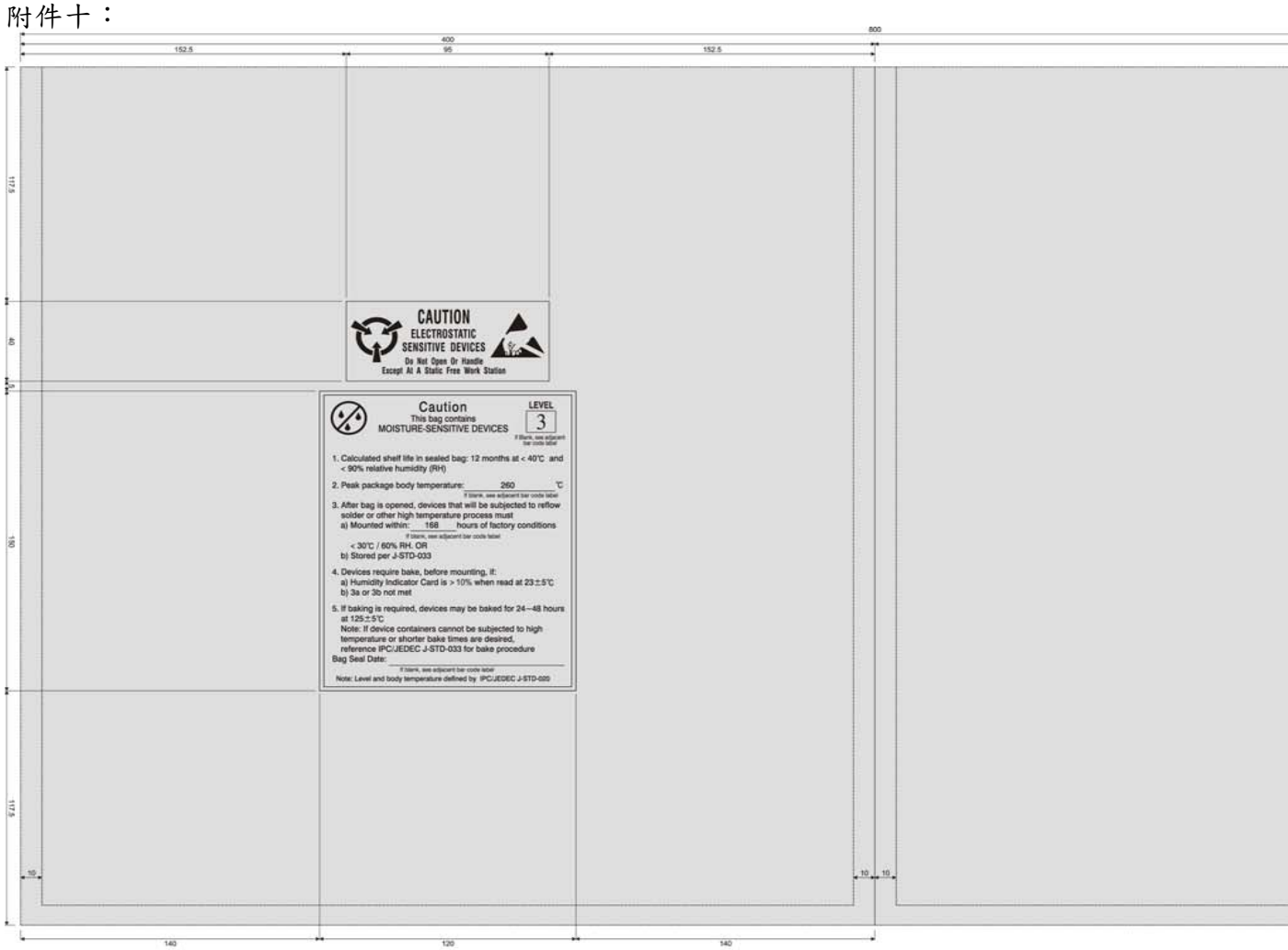
附圖二：Tape & Reel Information : SO-8/ESOP-8





1.All Dimensions Are Shown in Millimeters.
2. Packing : 3000 pcs / reel.

附件十：



文件編號：QWMPC-7801
版　　別：39
頁　　碼：34

富鼎先進電子股份有限公司

包裝規範

附件十-1：

文件編號：QWMPC-7801
版　　別：39
頁　　碼：35

富鼎先進電子股份有限公司
ADVANCED POWER ELECTRONICS CORP.

SO8-HF(E) Material list

Parts	Material Supplier	Material P/N	Country		Parts Weight (mg)	Substance	Weight (mg)	Per
Compound	Sumitomo	G600FL	China	49.81%	43.063	Epoxy Resin A	3.23	3
						Epoxy Resin B	1.29	1
						Phenol Resin	1.29	1
						Silica(Amorphous) A	35.74	4
						Silica(Amorphous) B	1.29	1
						Carbon Black	0.22	0
Die attach	Heraeus	PbSn5Ag2.5-D3-RM218-8	China	6.81%	5.887	Pb	5.45	6
						Sn	0.29	0
						Ag	0.15	0
Lead Frame	ASM	A194+Ag	China	39.69%	34.320	Cu	32.58	3
						Fe	0.81	0
						Pb	0.00	0
						P	0.03	0
						Zn	0.04	0
						Ag	0.86	0
Plating	ASEM	Sn	China	1.27%	1.094	Sn	1.09	1
						others	0.00	0
Gate Wire	Heraeus	Au wire	China	0.06%	0.056	Au	0.06	0
						others	0.00	0
Source Wire	Runxiang	Al wire	China	2.36%	2.040	Al	2.04	2
						others	0.00	0
				100.00%	86.46		86.46	10

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SO8-HF(G)　Material list

Parts	Material Supplier	Material P/N	Country		Parts Weight (mg)	Substance	Weigh
Compound	HITACHI	CEL-9240HF	JAPAN	47.35%	43.85	Epoxy resin 1	1.1
						Epoxy resin 2	0.3
						Epoxy resin 3	1.6
						Hardener 1	1.7
						CaRBON Black	0.0
						Amorphous silica	38.
						Crystal silica	0.2
SOLDER PASTE	Indium	Pb92.5Sn5Ag2.5	U.S.A	15.23%	14.10	Ag	0.3
						Pb	11.
						Sn	0.6
						Rosin	0.7
						Proprietary	0.4
Lead Frame	ASM	A194	Hong kong	33.29%	30.83	Cu	29.
						Fe	0.7
						Pb	0.0
						P	0.0
						Zn	0.0
						Ag	0.2
Plating	REDSUN	Sn100E	Taiwan	2.76%	2.56	Sn	2.5
						Impurity	0.0
Wire-1	AMETEK(SPM) TANAKA	Al	Malaysia SINGAPORE	1.35%	1.25	Al	1.2
						Impurity	0.0
Wire-2	HERAEUS	Cu	MALAYSIA	0.01%	0.0075	Cu	0.0
						Impurity	0.0
				100.00%	92.61		92.

ADVANCED POWER ELECTRONICS CORP.

Recommended Reflow Profile for Lead(Pb) Free Soldering (Pure Matte Tin Plating)

Lead(Pb) free solders which require to use higher reflow temperature. Advanced Power Electronics Corp. has studied the reliability of our products at higher reflow temperature. Customer may use below temperature profile for the solders requirement.

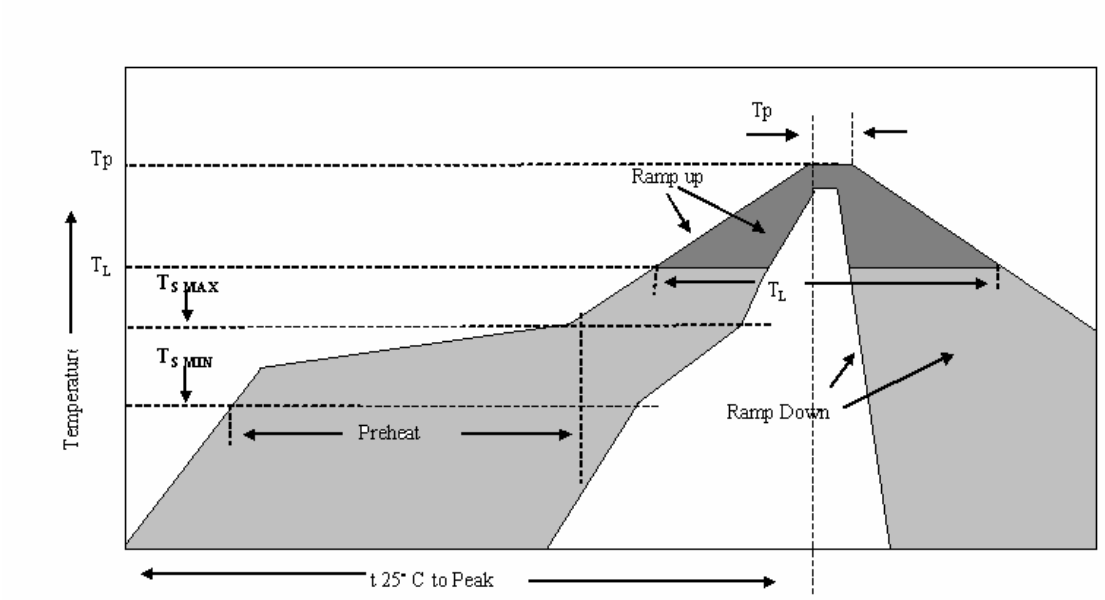


Table 1. Lead-Free Reflow Rrofile Recommendation(IPC/JEDEC J-STD-020C)	
Reflow Parameter	Lead-Free Assembly
Minimum preheat temperature(Ts_{MIN})	150° C
Maximum preheat temperature(Ts_{MAX})	200° C
Preheat Time	60-180 seconds
Ts_{MAX} TO T_L ramp-up rate	3° C/second maximum
Time above temperature T_L (t_L)	217° C 60-150 seconds
Peak Temperature (T_p)	260° C
Time 25 C To Tp	8 minute maximum
Time within 5c of Peak Tp	20-40 seconds
Ramp-down rate	6° C/second maximum

* Could meet three 3 cycles

Reliability Test Report

AP4439GM-HF

I. Accelerated Life Times Stress Test

II. Environmental Stress Test

SO-8(M)

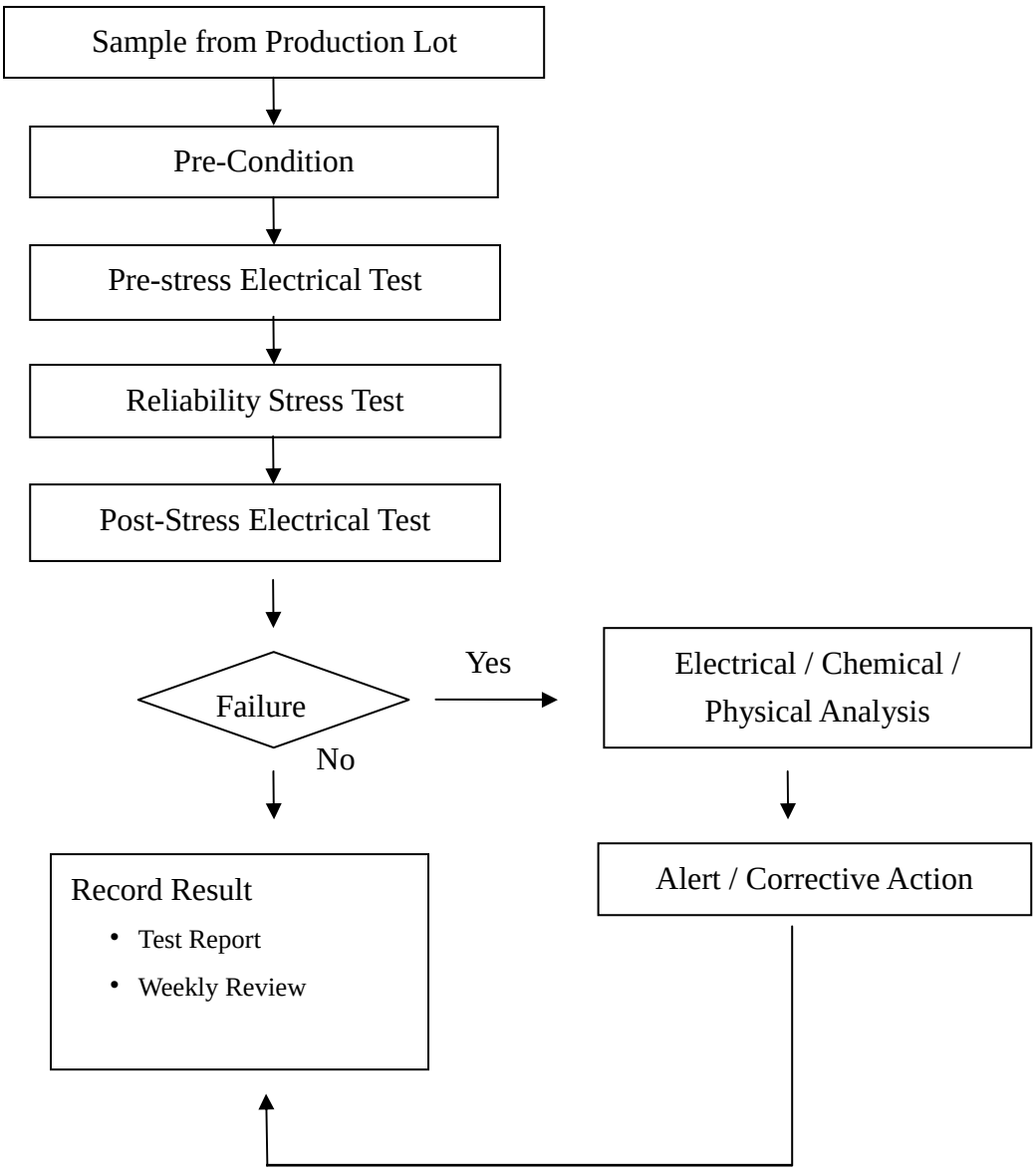
Approved by	Prepared by
M. H. Lin	S. H. Tsai
Date: 2012/12/06	Date: 2012/12/06

TABLE OF CONTENTS

1. Introduction

This report records the APEC product reliability test procedure, items and results; give a clear overview of reliability qualification test.

2. Test Procedure



2.1 Pre-Condition (SMD Packages devices only)

This is to simulate the product storage, shipping and customer application environment.

Step 1: Baking 125℃ , 24hrs.

Step 2: 85℃ / 85%R.H. Soaking 168hrs. (J-STD-020 Level 1)

Step 3: IR Reflow Tmax.= 260℃ , 3cycles

2.2 Sampling plan

Based on LTPD = 10% , AC=0

3. Accelerated Life Time Stress Test

3.1 Test Level

■ Routine Monitor Qualification

□ New Product Qualification

□ Engineer / Customer Request Qualification

3.2 Test Result

Test Item	Sample Size	Total Device (hours)	Result	Failure Rate (FITs)	MTTF' (10^6) Devices hrs.
High Temperature Gate Bias(HTGB)	22	22000 hrs	Pass	1186.08	0.84
High Temperature Reverse Bias (HTRB)	22	22000 hrs	Pass	1186.08	0.84

CL = 90% ; Ea = 0.7eV ; Operating Temp. = 70℃

3.3 Test Item Description

3.3.1 High Temperature Gate Bias (HTGB)

- Reference Standard

  EIAJ ED-4701 D323

  HTGB Operation spec. (QWRAD-7117)

- Condition:

  Temperature: Max. Operating Temperature

Test Point: 0, 168, 500, 1000 Hours Nominal
Bias: Max. VGS Rating

3.3.2 High Temperature Reverse Bias (HTRB)

- Reference Standard
  EIAJ ED-4701 D321
  HTRB Operation spec. (QWRAD-7118)
- Condition:
  Temperature: Max. Operating Temperature
  Test Point: 0, 168, 500, 1000 Hours Nominal
  Bias: VS=VG=0V, VD= 80% of Max. BVDSS Rating

4. Environmental & Package Stress Test

4.1 Test Level

■ Routine Monitor Qualification
□ New Product Qualification
□ Engineer / Customer Request Qualification

4.2 Test Result

Test Item	Sample Size	Test Time (hours/ cycles)	Result
HTST	22	1000 hrs.	Pass : 0/22
H3TRB	22	1000 hrs.	Pass : 0/22
THST	22	1000 hrs.	Pass : 0/22
PRCL	22	10K cyc.	Pass : 0/22
TCT	22	1000 cyc.	Pass : 0/22
PCT	22	168 hrs.	Pass : 0/22
TST	22	100 cyc.	Pass : 0/22
HAST	22	96 hrs.	Pass : 0/22

The pre-conditioning (SMD Packages devices only)

4.3 Test Item Description

4.3.1 High Temperature Storage Test (HTST)

・Reference Standard

EIAJ ED-4701 B111A

HTST Operation spec. (QWRAD-7116)

・Condition:

Temperature:	150℃	
Test Point:	0, 1000 Hours	Nominal
Bias:	no Bias	

4.3.2 High Temperature & Humidity Reverse Bias (H3TRB)

・Reference Standard

EIAJ ED-4701 B122A

H3TRB Operation spec. (QWRAD-7111)

・Condition:

Temperature:	85℃	
Relative Humidity:	85% R.H.	
Test Point:	0, 168, 500, 1000 Hours	Nominal
Bias:	VS=VG=0V,	
	VD= 80% of Max. BVDSS Rating up to 100V	

4.3.3 Temperature Humidity Storage Test (THST)

・Reference Standard

EIAJ ED-4701 B121

THST Operation spec. (QWRAD-7115)

・Condition:

Temperature:	85℃	
Relative Humidity:	85% R.H.	
Test Point:	0, 1000 Hours	Nominal
Bias:	no bias	

4.3.4 Power Cycling Test (PRCL)

- Reference Standard
  EIAJ ED-4701 D322
  PRCL Operation spec. (QWRAD-7114)
- Condition:
  Temperature: Tj=△100℃
  Test Point: 0, 10000 Cycles Nominal
  Bias (Set to give) : △T=100℃

4.3.5 Temperature Cycling Test (TCT)

- Reference Standard
  MIL STD 883E 1010.7
  TCT Operation spec. (QWRAD-7113)
- Condition:
  Temperature: Tmin.= -65℃ , Tmax.=150℃ , △T=215℃
  Test Point: 0, 1000 cycles Nominal

4.3.6 Pressure Cooker Test (PCT)

- Reference Standard
  JESD22-A102C
  PCT Operation spec. (QWRAD-7110)
- Condition:
  Temperature: 121℃
  Relative Humidity: 100% R.H.
  Pressure: 2 atm
  Test Point: 0, 168 Hours Nominal

4.3.7 Thermal Shock Test (TST)

- Reference Standard
  MIL STD 883E 1011.9
  TST Operation spec. (QWRAD-7112)
- Condition:
  Temperature: Tmin.= -65℃ , Tmax.=150℃ , △T=215℃
  Test Point: 0, 100 Cycles Nominal

4.3.8 Highly Accelerated Stress Test (HAST)

- Reference Standard

  JESD22-A118

- Condition:

  Temperature: 130℃

  Relative Humidity: 85% R.H.

  Pressure: 33.3 psia / 230kPa

  Test Point: 0, 96 Hours Nominal

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