4-Channels LED Gate Driver

Features

- **Operating Voltage: 3-5.5V**
- **4 Channels Sink Output, 80m? Ron/Channel**
- **3A sink current**
- **2 Bits Input Smart-Bus Supports Max. 32-Lines Sequential-Scanning**
- **Line synchronous shutdown function**
- **Auto bus fault protection**
- **Thermal Protection**
- **De-Ghost Function**
- **TQFN3x3-16 and SSOP-16 Packages**
- **Lead Free and Green Devices Available (RoHS Compliant)**

General Description

The APL5015 has 4 output channels, it supports maximum to 32 lines sequential scanning system for LED moving sign dynamic display; it has 2-bits input smart-bus & 2 bits ternary Device-Address-Bus for multi-chips cascade link and no any external decoders. It supports line synchro-nous shutdown by the BLK pin .

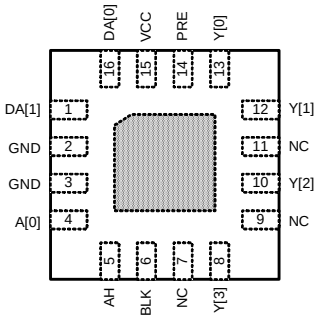
The APL5015 has a channel self-check function, when the channel turns on more than 35ms, it will disable the channels output until the channel restarts in the next cycle.

The APL5015 has a integrate Thermal Protection, the maximum is 150°C.

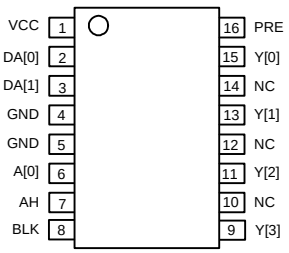
Applications

- **Outdoor LED Video Displays**
- **Indoor LED Video Displays**
- **Vairable Message Signs**
- **Gaming Features**

Pin Configuration

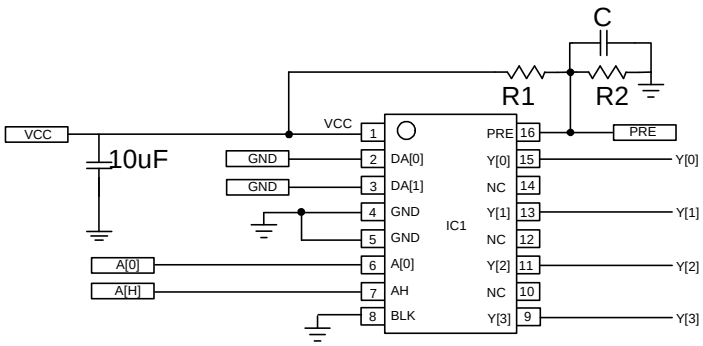


TQFN3x3-16
(Top View)

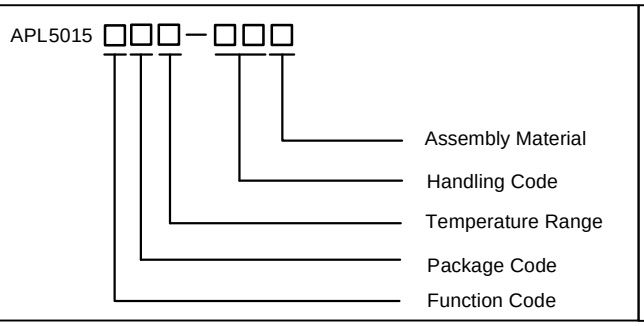


SSOP-16
(Top View)

Simplified Application Circuit



Ordering and Marking Information



Package Code
N : SSOP-16
QB: TQFN3x3-16
Operating Junction Temperature
I : - 40 to 85 °C
Handling Code
TR : Tape & Reel
Assembly Material
G : Halogen and Lead Free Device

APL5015N :	L5015 ● XXXXX	XXXXX – Date Code
APL5015QB :	L5015 ● XXXXX	XXXXX – Date Code

Note : ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classifi-cation at lead-free peak reflow temperature. ANPEC defines “Green” to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{CC}	VCC power input pin	-0.3 ~ 6	V
-	Other Pins	-0.3 ~ V_{CC}	V
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C
T_{SDR}	Maximum Lead Soldering Temperature(10 Seconds)	260	°C

Note1: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under ”recommended operating conditions” is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter		Typical Value	Unit
θ_{JA}	Junction-to-Ambient Resistance in free air (Note 2)	SSOP-16	155	°C/W
		TQFN3x3-16	50	

Note 2: θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operation Conditions(Note 3)

Symbol	Parameter	Range	Unit
V_{CC}	VCC power input pin	4.5 ~ 5.5	V
I_{OUT}	Y[0:3] sink current	0~3	A
FSW	A0 input frequency	Up to 100	KHz
T_A	Ambient Temperature	-40 ~ 85	°C
T_J	Junction Temperature	-40 ~ 125	°C

Note 3: Refer to the typical application circuit

Electrical Characteristics

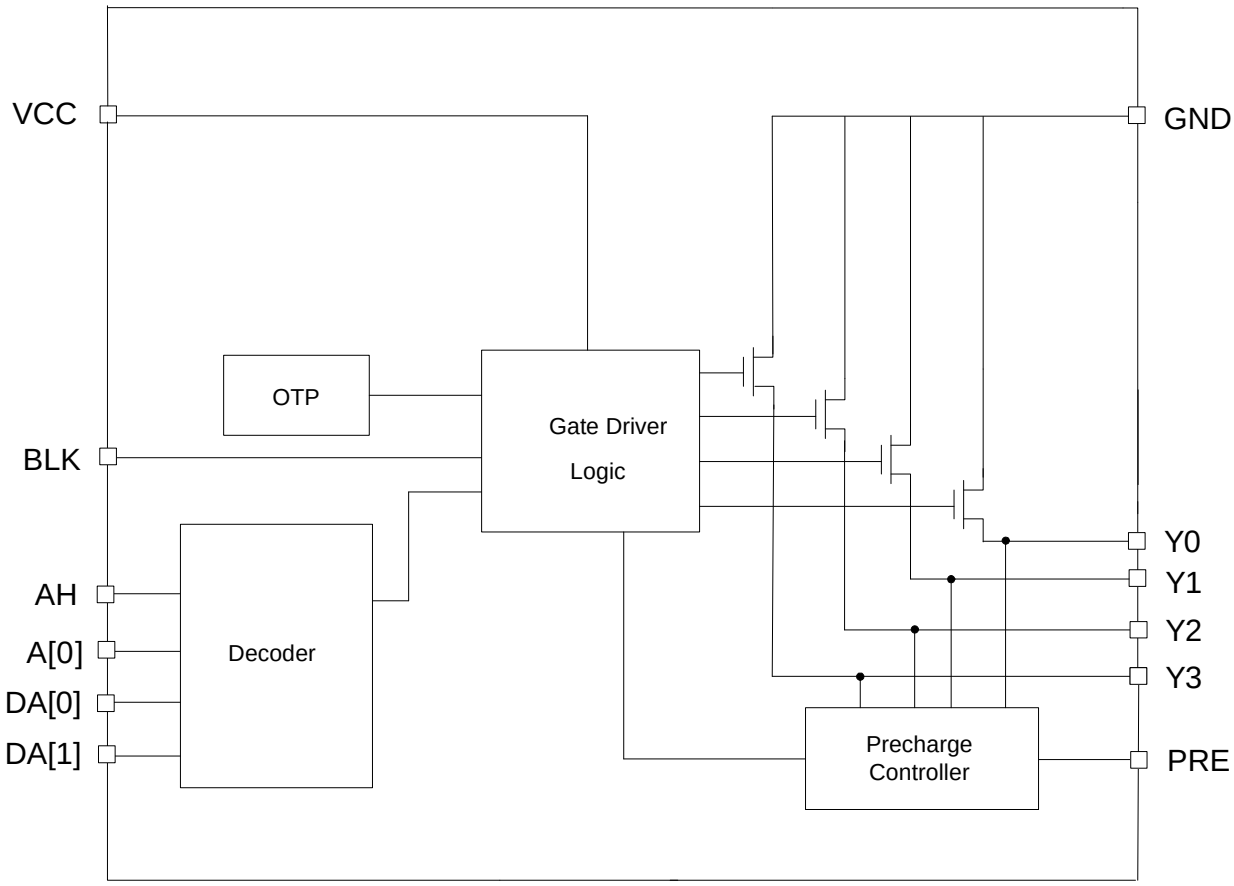
Unless otherwise specified, these specifications apply over VCC=5V, and T_A= 25 °C.

Symbol	Parameter	Test Conditions	APL5015			Unit
			Min	Typ	Max	
SUPPLY CURRENT						
I_Q	VCC Quiescent Current	VCC =5V	-	200	300	uA
POWER-OK INDICATOR						
V_{UVLO_H}	POK Threshold_H	VCC=5V	-	2.4	-	V
V_{UVLO_L}	POK Threshold_L		-	2.2	-	V
POWER SWITCH						
$R_{DS(ON)}$	VCC to Y[0:3] Power Switch On Resistance	VCC=5V, I_{OUT}=1A	-	80	-	mΩ
Slew Rate	Y[0:3] Power Switch Rising	VCC=5V ,output channels add R=5.1K and C=20nF to GND	-	1.5	-	V/us
	Y[0:3] Power Switch Falling	VCC=5V ,output channels add R=5.1K and C=20nF to GND	-	75	-	
LOGIC INPUTS(DA0,DA1,AH,A0,BLK)						
V_L	Input Low Voltage		-	-	0.2xV_{CC}	V
V_H	Input High Voltage		0.8xV_{CC}	-	-	V
I_{LOGIC_L}	BLK、A0、AH Pull - Low Current		-	1	-	uA
V_{HOLD}	Output Holding Voltage	VCC=5V, V_{PRE}=0V output channels add R=5.1K and C=20nF to GND	-	1.5	-	V
DELAY TIME						
$T_{D(ON)}$	AH High to Low to Y0 turn-on Delay Time		-	50	-	ns
$T_{D(OFF)}$	A0 Low to High to Y0 turn-off Delay Time		-	20	-	ns
$T_{D(Y)}$	Y0 turn-off to Y1 turn-on Delay Time		-	15	-	ns
	A0 to AH input signal delay time		-50	-	50	ns
PROTECTION						
T_{OTR}	Over-Temperature Threshold	T_J rising	-	150	-	°C
	Over-Temperature Hysteresis		-	20	-	°C
T_{MAX_ON}	Output Maximum Turn-on Time		-	35	-	ms

Pin Description

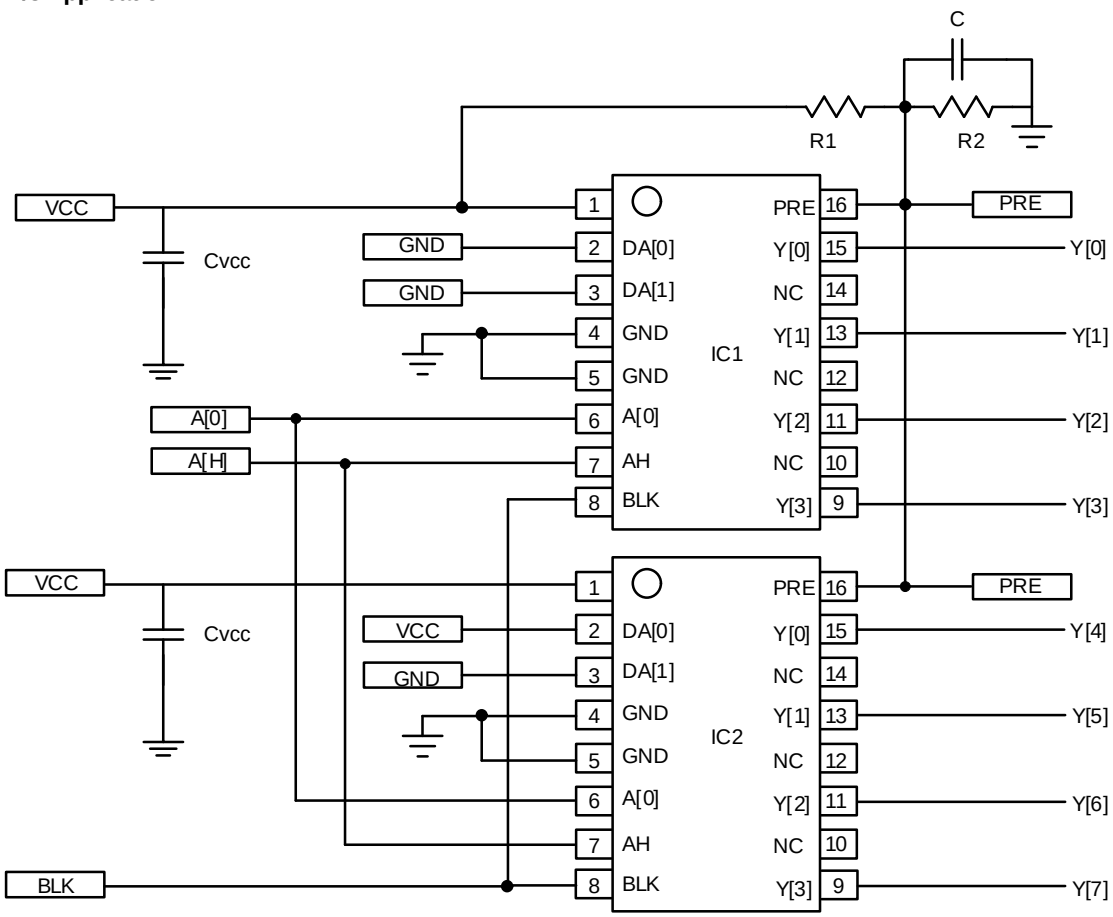
PIN		NAME	FUNCTION
NO.			
SSOP-16	TQFN3x3		
1	15	VCC	IC Power Input Pin.
2	16	DA[0]	Device Address-Bus Control Pin.
3	1	DA[1]	Device Address-Bus Control Pin.
4	2	GND	IC Ground Pin.
5	3	GND	IC Ground Pin.
6	4	A[0]	Line address-bus LSB Control Pin.
7	5	AH	Line address-bus MSB Control Pin
8	6	BLK	Sync-Block Input.
9	8	Y[3]	LED Line Output-Bus Pin.
10	7	NC	No Connection.
11	10	Y[2]	LED Line Output-Bus Pin.
12	9	NC	No Connection.
13	12	Y[1]	LED Line Output-Bus Pin.
14	11	NC	No Connection.
15	13	Y[0]	LED Line Output-Bus Pin.
16	14	PRE	Pre-charge Input.

Block Diagram



Typical Application Circuit

Duty=1/8 Application



Component recommendation value

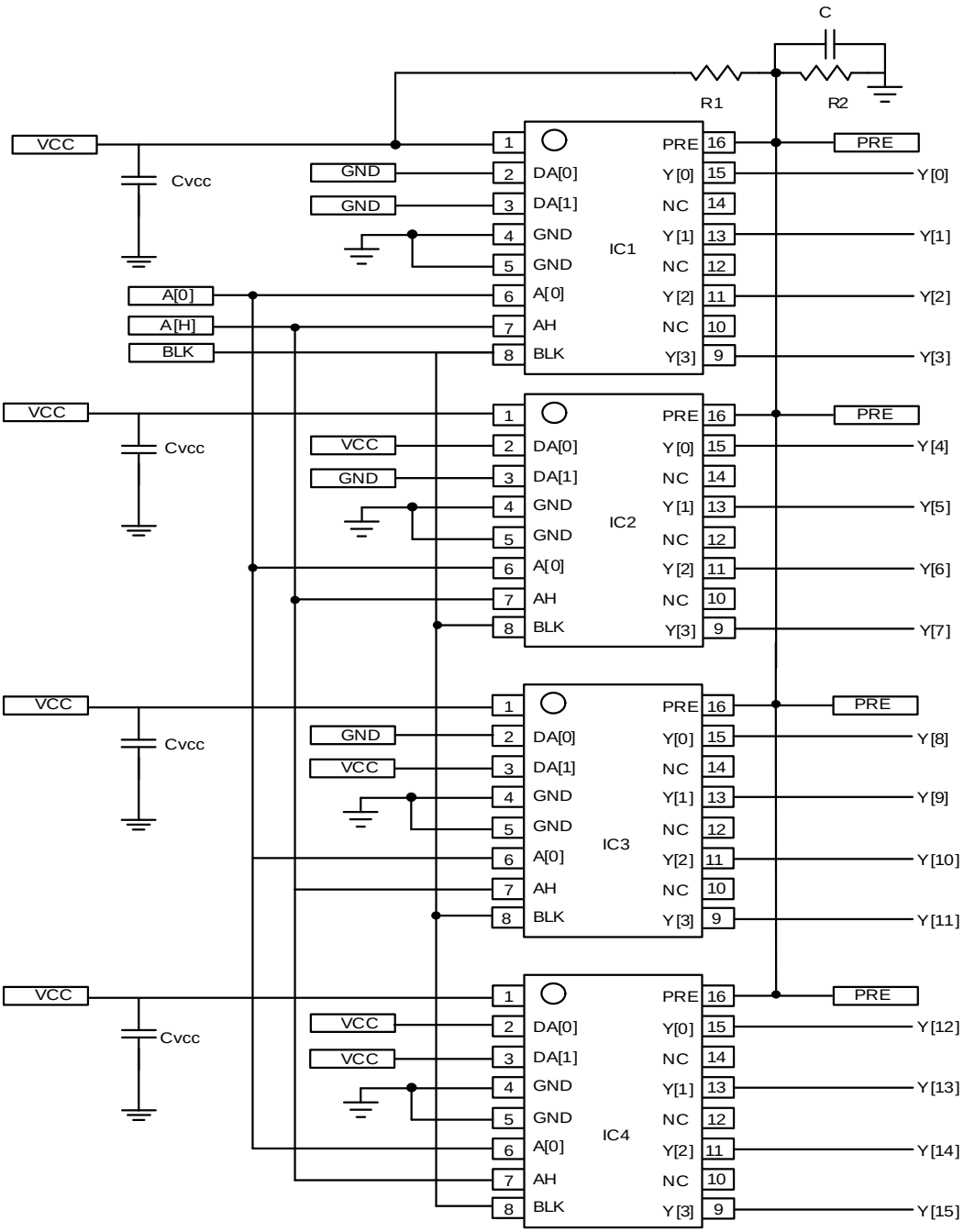
R1 & R2 =1K~100K

C=0.1uF~1uF

C_{VCC}=4.7uF~10uF

Typical Application Circuit

Duty=1/16 Application



Component recommendation value

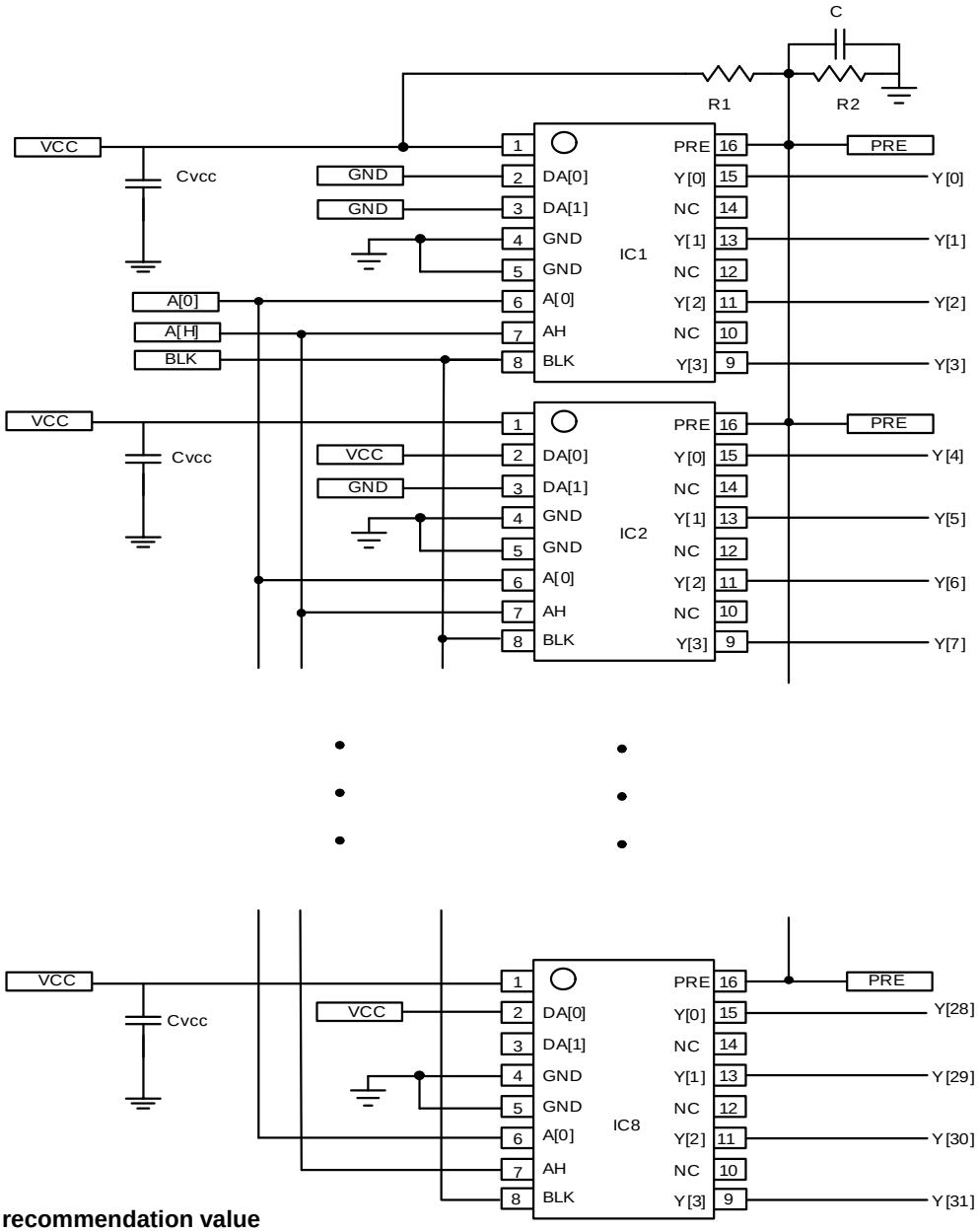
R1 & R2 =1K~100K

C=0.1uF~1uF

C_{VCC}=4.7uF~10uF

Typical Application Circuit

Duty=1/32 Application



Component recommendation value

R1 & R2 =1K~100K

C=0.1uF~1uF

C_{VCC}=4.7uF~10uF

Timing Chart

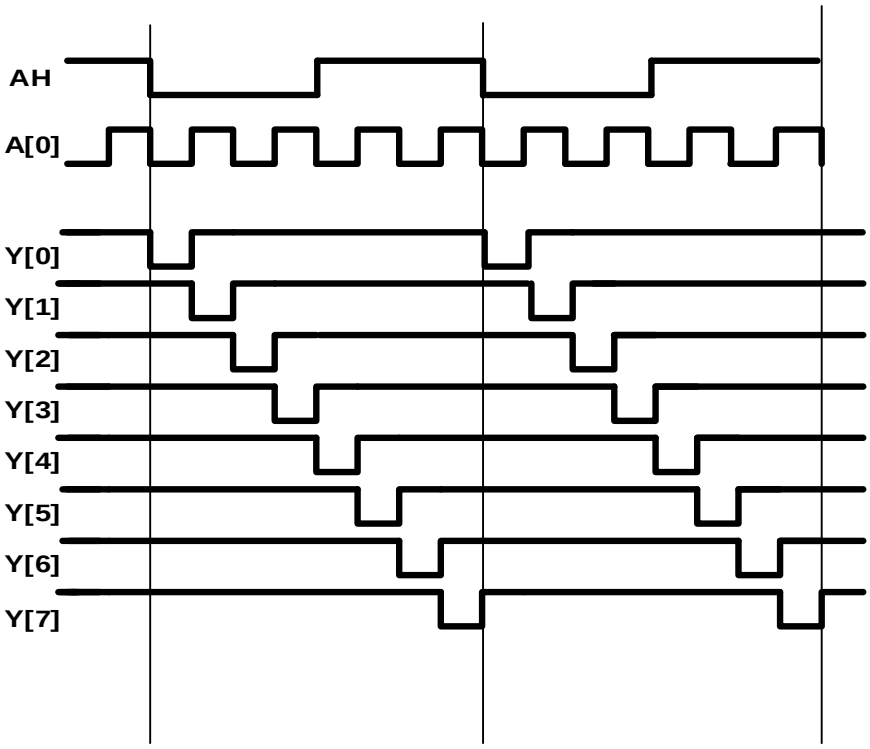


Figure1. 8 Lines(1/8 duty) sequential scanning timer-diagram

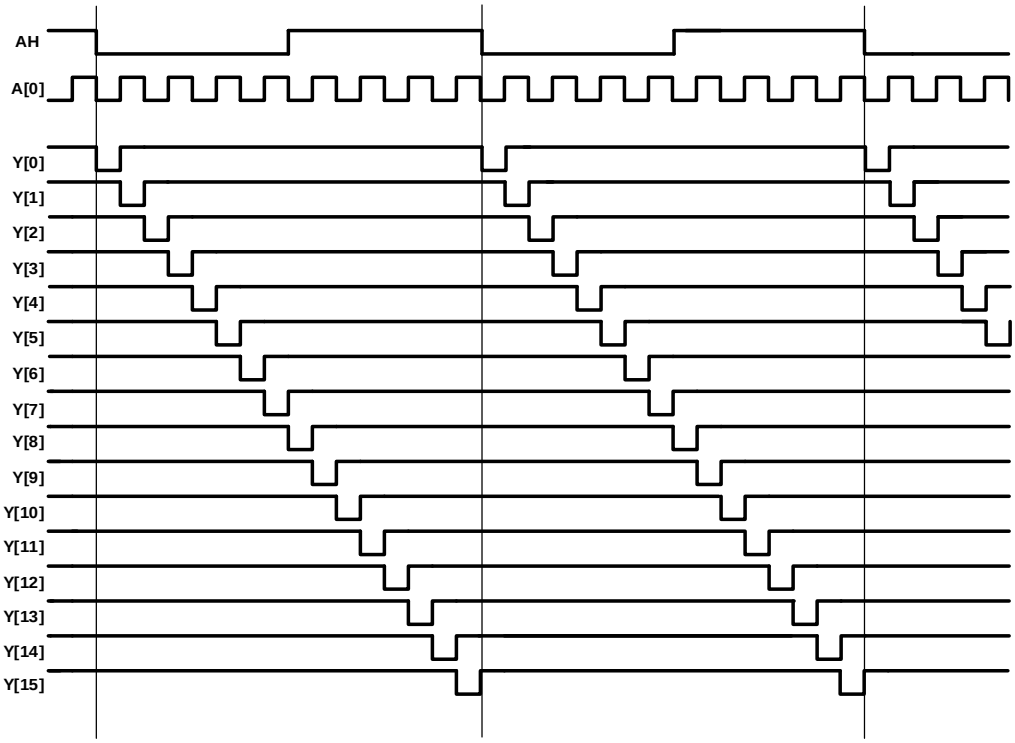


Figure2. 16 Lines(1/16 duty) sequential scanning timer-diagram

Timing Chart

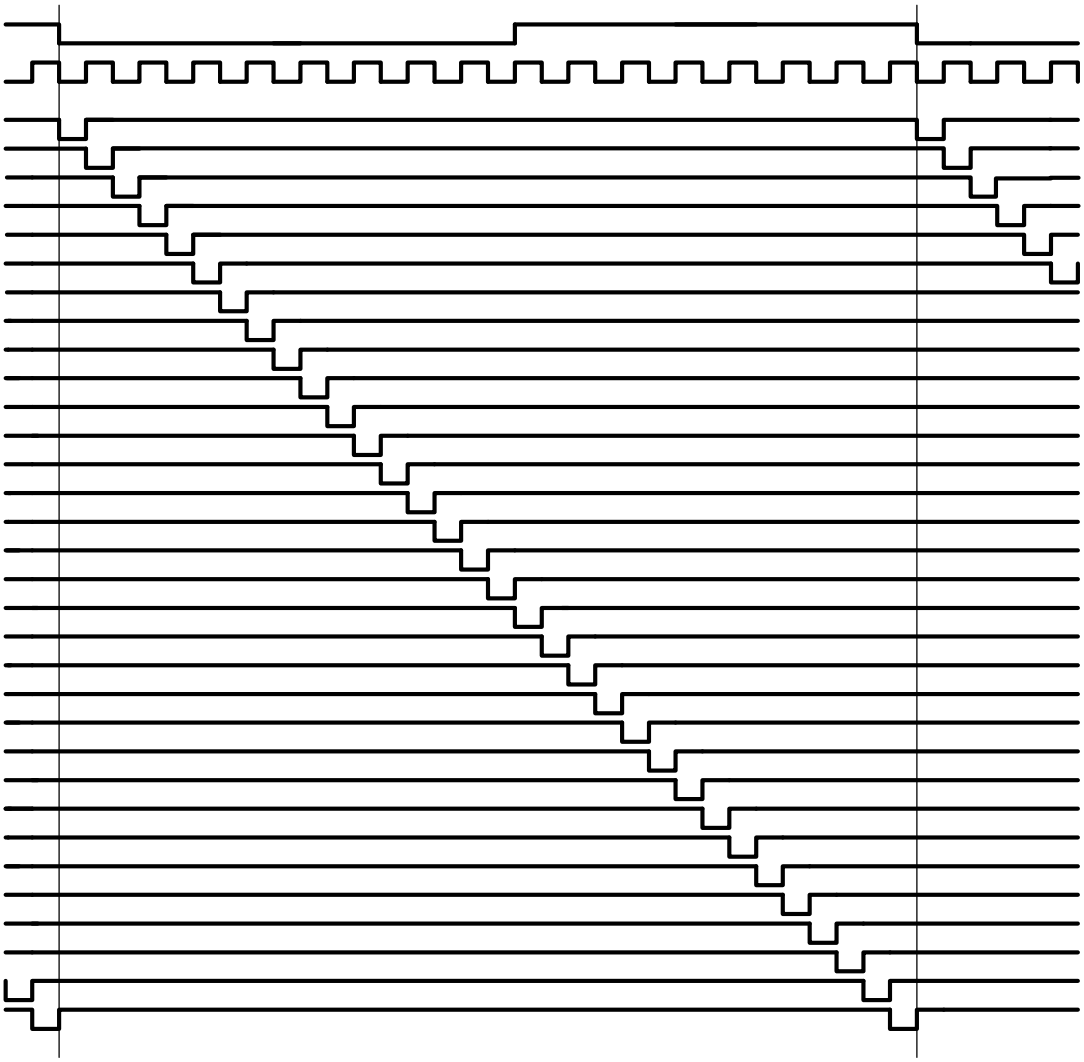
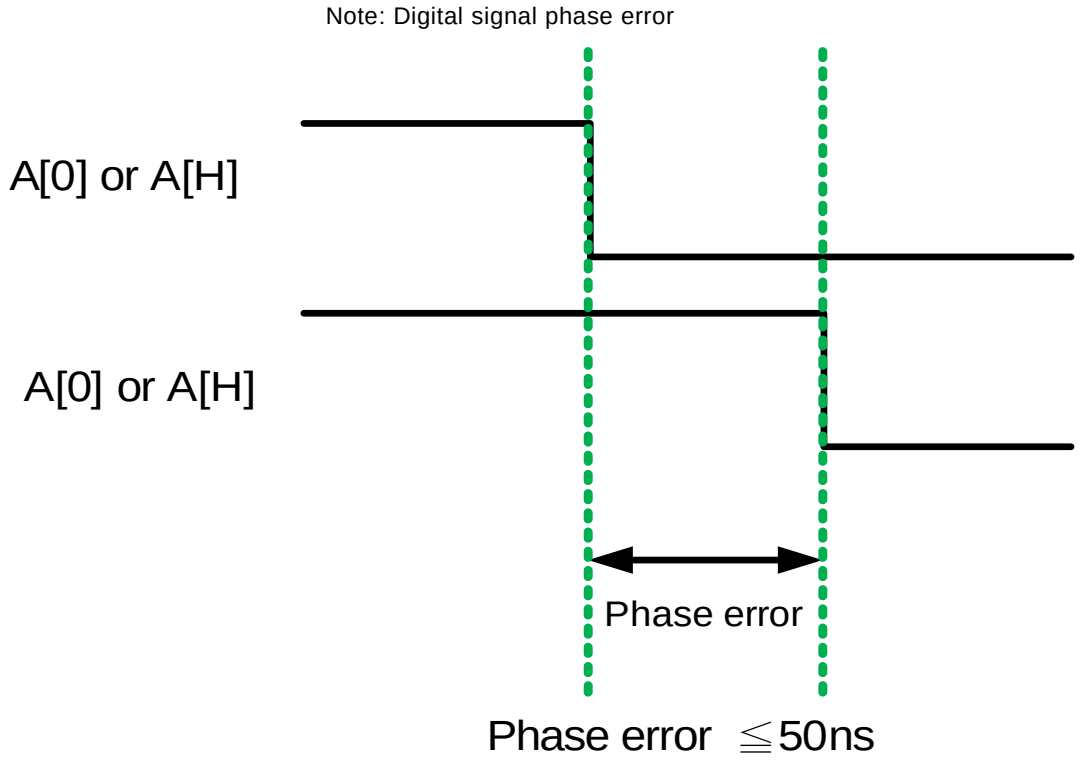


Figure3. 32 Lines(1/32 duty) sequential scanning timer-diagram

Timing Chart



Function Description

Device Address Bus Configuration

Device address bus(DA) are 2bits ternary(three hex decimal) input signals, it can be set High/Low/Float 3-states, the table is the device location with DA[1:0]; it supports max. to 8 devices and needn't any external hard ware.

DA[0]	DA[1]	Binary Code	Device No.
0	0	000	1
1	0	001	2
0	1	010	3
1	1	011	4
NC	0	100	5
NC	1	101	6
0	NC	110	7
1	NC	111	8
NC	NC	NC	OFF

Table1. DA[1:0] Corresponds to Device No. Table.
0: Logic low, 1: Logic high, NC: Floating

Line address Bus Configuration

Using 2bits smart bus simplifies system design, AH is the line address bus MSB, A[0] is the line address bus LSB, for example, 32 lines output, line address bus A[4:0], the AH=A[4]; A[3:1] can be ignored.

Pre-Charge

When the channel is on, the output goes low, all other channels will be off and the output voltage will be the VHOLD voltage.
When VPRE < 0.35V, VHOLD will be from 1.2V to 1.8V.
When VPRE > 0.35V, VHOLD is equal to VPRE, this voltage can be set by users.

Time-Out

APL5015 has a long time channel conduction protection, when the output channel is turned on more than 35ms, the channel is cut off, the channel restarts in the next cycle.

Over Temperature Protection (OTP)

When the junction temperature rises above the threshold temperature T_{OTR}, all channels Y [0: 3] are turned off and the IC enters the over temperature protection state. When the junction temperature drops to 20°C, all channels Y [0: 3] turn on again. OTP with a 20oC hysteresis design re-duces the average T_J for sustained thermal overload and extends the life of the APL5015.

BLK

In normal operating mode, channel switching is determined by A0 and AH. If we want the channel to be prematurely closed, it can be controlled by the BLK. As shown in Figure 2. When BLK changes from high to low during the A0 switching cycle, the channel can be closed early.

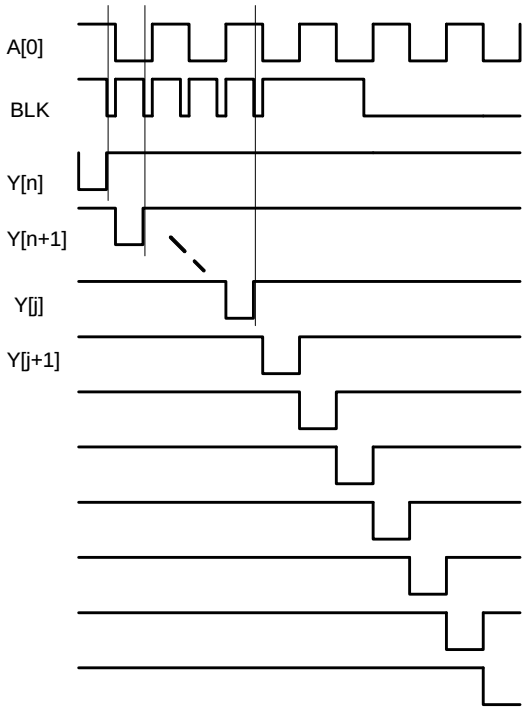


Figure2. Sync shutdown line timer-diagram

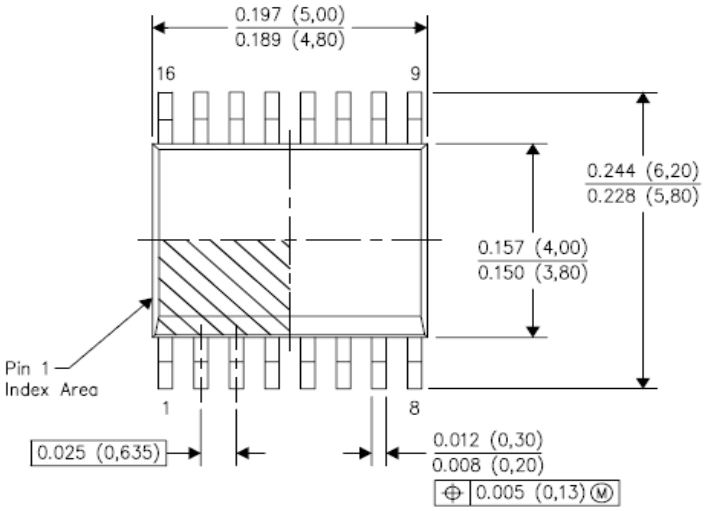
Application Information

Layout Guidelines

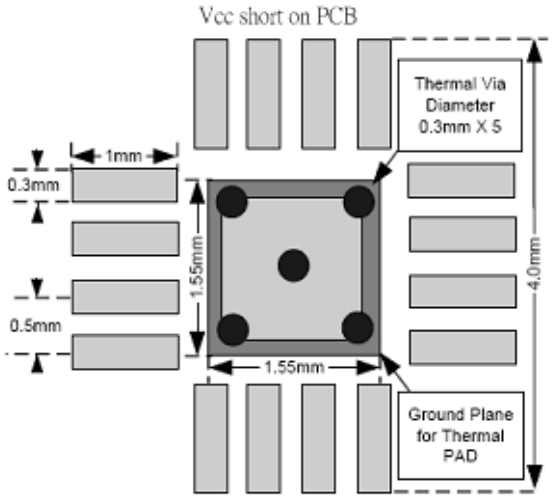
- All components should be placed close to the APL5015.For example, the input capacitor should be close to APL5015's VCC pin to decouple the power rail noise.
- The output traces should be short,wide(>60mil),symmetric.
- The power trace width should be greater than 60mil.
- The TQFN Thermal PAD should be soldered on PCB,and the ground plane needs soldered mask(to avoid short circuit)except the Thermal PAD area.

The TQFN package has a single VCC pin,they must be short on the PCB

PCB Drawings

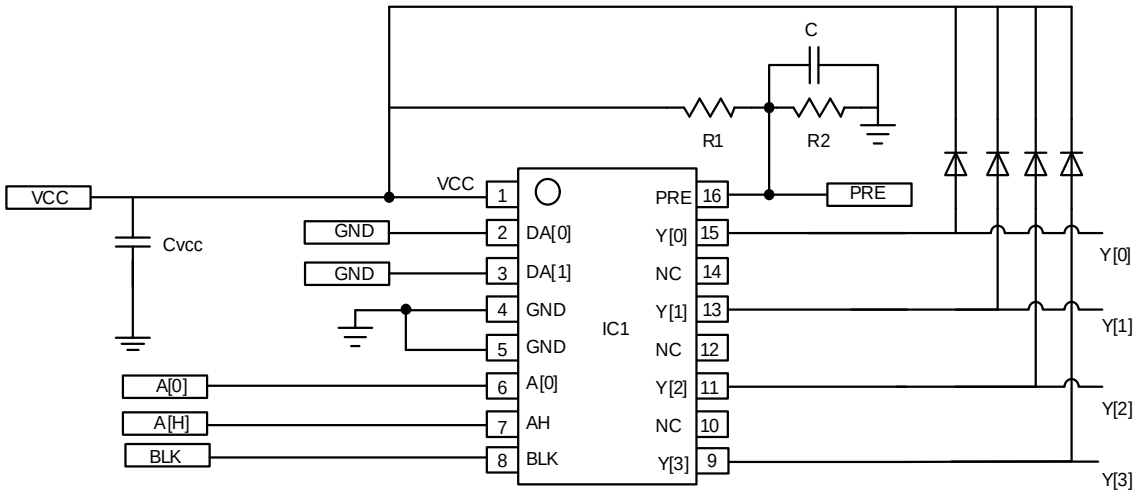


SSOP-16 Layout Guide



TQFN3x3-16 Layout Recommendation

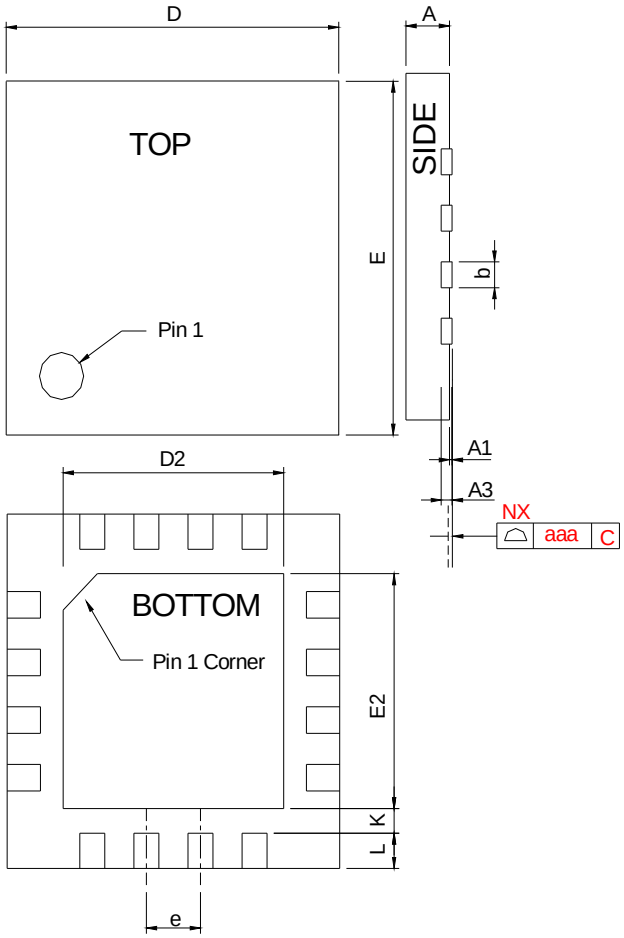
Improve Air ESD level



Improve ESD level circuit

Package Information

TQFN3x3-16

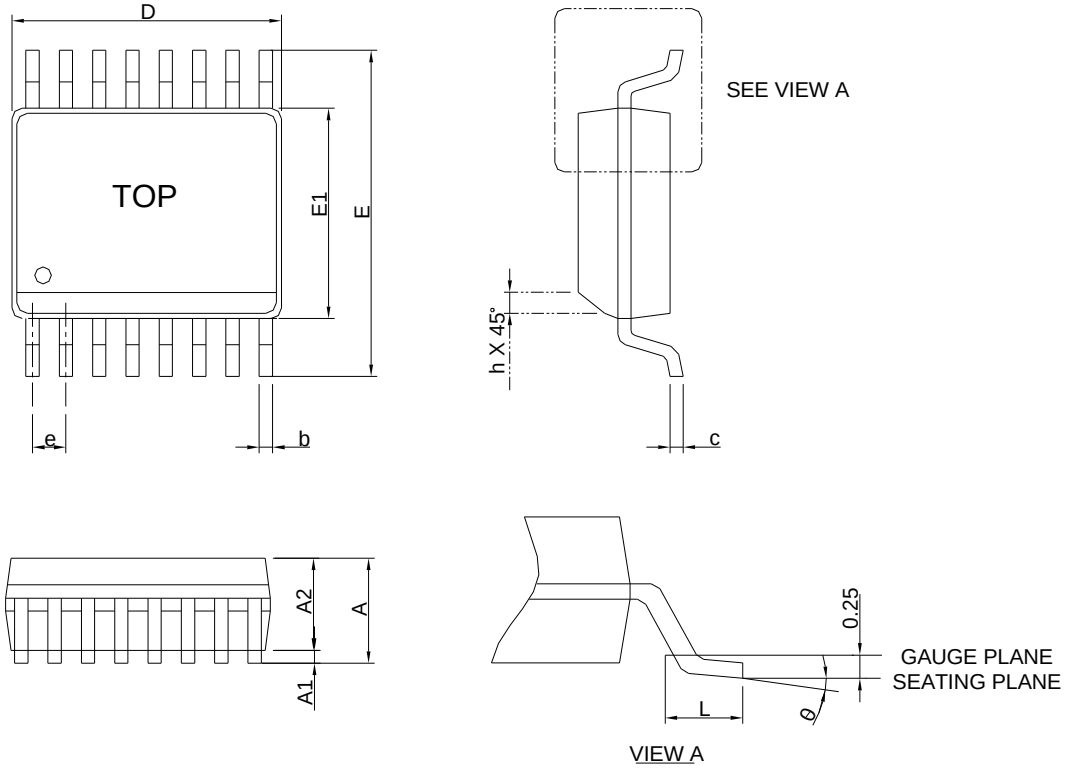


SYMBOL	TQFN3*3-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
A3	0.20 REF		0.008 REF	
b	0.18	0.30	0.007	0.012
D	2.90	3.10	0.114	0.122
D2	1.50	1.80	0.059	0.071
E	2.90	3.10	0.114	0.122
E2	1.50	1.80	0.059	0.071
e	0.50 BSC		0.020 BSC	
L	0.30	0.50	0.012	0.020
K	0.20		0.008	
aaa	0.08		0.003	

Note : 1. Followed from JEDEC MO-220 WEED-4.

Package Information

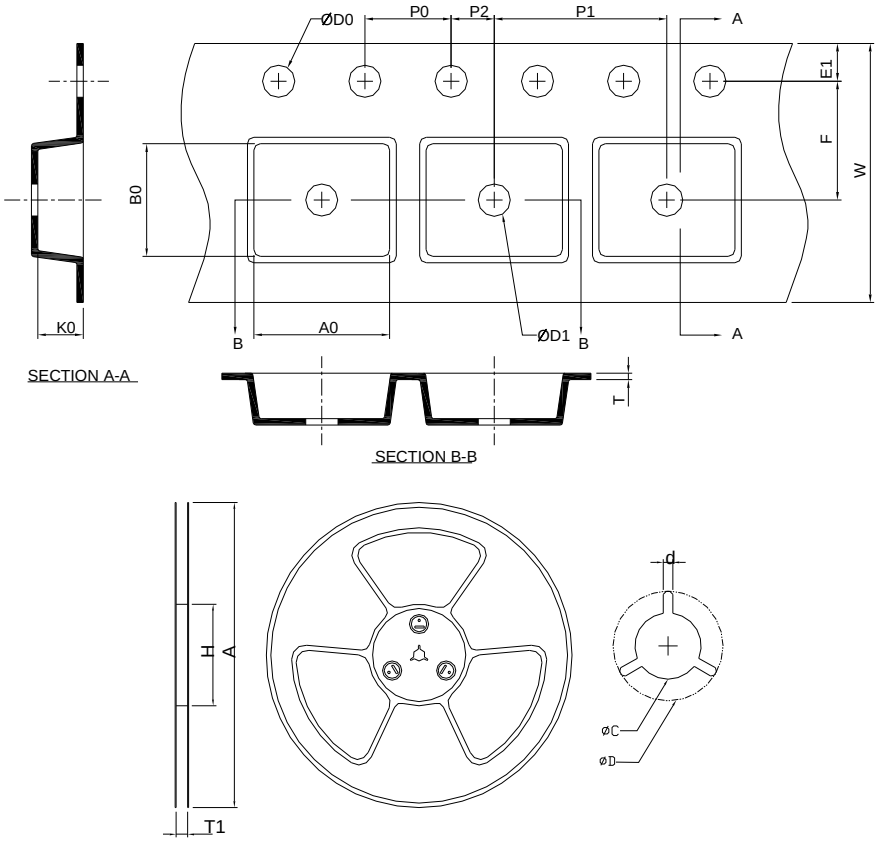
SSOP-16



SYMBOL	SSOP-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.75		0.069
A1	0.10	0.25	0.004	0.010
A2	1.24		0.049	
b	0.20	0.30	0.008	0.012
c	0.15	0.25	0.006	0.010
D	4.80	5.00	0.189	0.197
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	0.635 BSC		0.025 BSC	
L	0.40	1.27	0.016	0.050
h	0.25	0.50	0.010	0.020
θ	0°	8°	0°	8°

Note : 1. Follow JEDEC MO-137 AB.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension "E" does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
SSOP-16	330.0±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.50±0.10
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.40±0.20	5.20±0.20	2.10±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
TQFN 3*3	330±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0±0.10	8.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	3.30±0.20	3.30±0.20	1.00±0.20

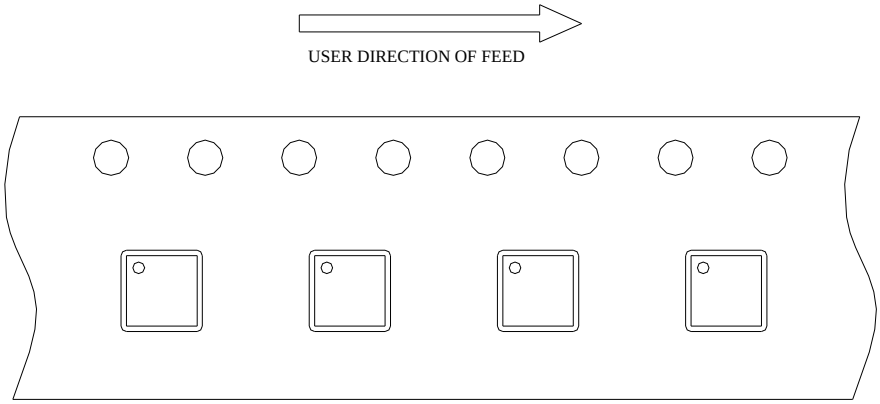
(mm)

Devices Per Unit

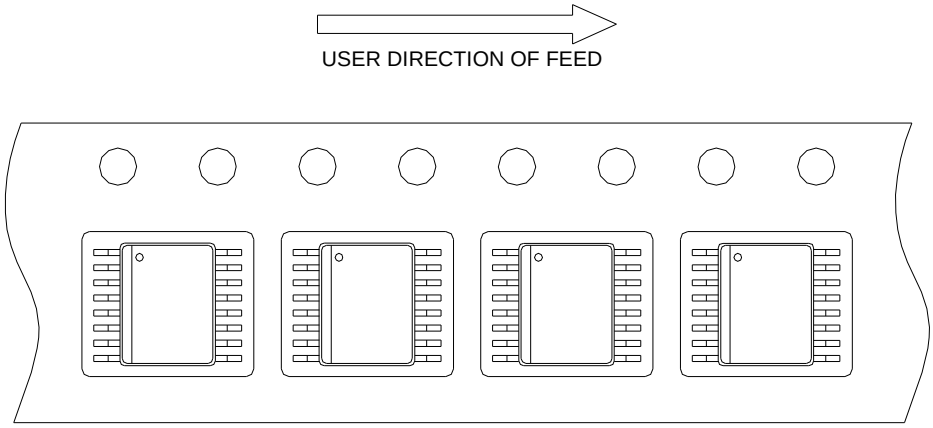
Package Type	Unit	Quantity
TQFN3x3	Tape & Reel	3000
SSOP-16	Tape & Reel	2500

Taping Direction Information

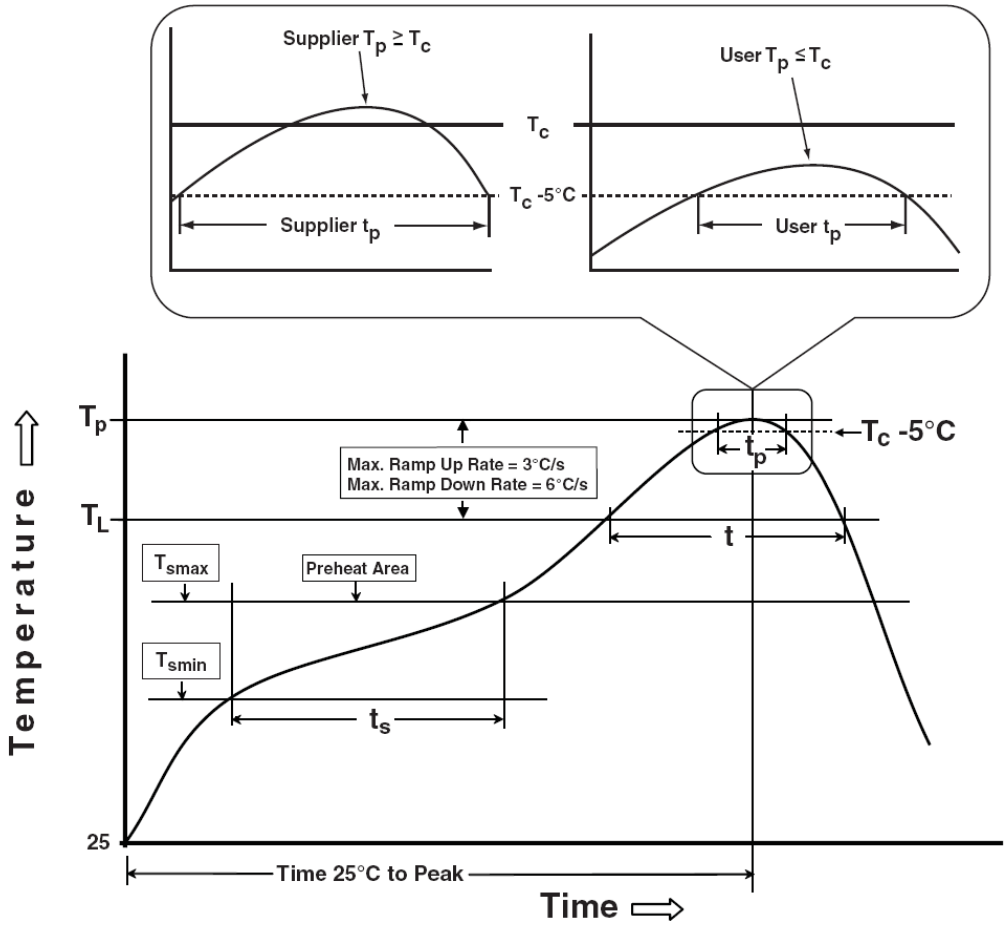
TQFN3x3-16



SSOP-16



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_P)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 ³350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HOLT	JESD-22, A108	1000 Hrs, Bias @ T_j=125°C
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
HBM	MIL-STD-883-3015.7	VHBM≧2KV
MM	JESD-22, A115	VMM≧200V
Latch-Up	JESD 78	10ms, 1_{tr}≧100mA

Customer Service

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