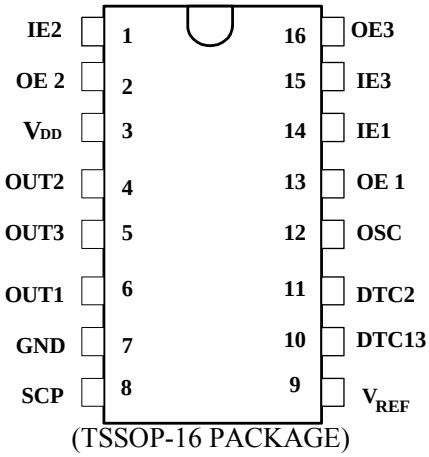
TRIPLE-CHANNEL PWM CONTROLLER

Features

- Complete PWM Power Control Circuitry
- Precision Reference：1.25V±1% (25 °C)
- Low Operating Voltage：2.5V to 7.0V
- Under-Voltage Lockout Protection
- Totem Pole Output
- Output Short Circuit Protection
- Low Dissipation Current：
  2.5mA at 500 kHz and 50% Duty Cycle
- Separate On / Off Control for CH1, CH3 Pair and CH2 (Refer to Function Table)
- Dead Time Control：0 to 100%
- Wide Operating Frequency：50 kHz to 1MHz
- Minimized External Components

Pin Configuration

TOP VIEW



(TSSOP-16 PACKAGE)

General Description

The AAT1100 provides an integrated triple-channel pulse-width-modulation (PWM) solution for the power supply of DC-DC system; this device offers system engineer the flexibility to custom-make the power supply circuitry to a specific application. Each channel contains its own error amplifier, PWM comparator, dead–time control (DTC) and output driver. The under-voltage protection, oscillator, short circuit protection and voltage reference circuit are common features of the three channels.

The AAT1100 contains two boost circuits (CH1, CH3) and a buck-boost circuit (CH2). DTC can be set to provide 0% to 100% dead-time through a divider network. Soft-Start can be implemented by paralleling the DTC resistor with a capacitor. Two DTC inputs are assigned for CH1, CH3 pair and CH2 individually, and DTC inputs can be used to control on / off operation. In addition, this device can operate from 2.5V to 7.0V supply voltages to achieve efficient operation in low power system.

With a minimal number of external components, the AAT1100 offers a simple and cost effective solution.

Function Table

Condition	Output		
	CH1	CH2	CH3
DTC13 > 0.3V, DTC2 > 0.3V	ON ”High”	ON ”Low”	ON ”High”
DTC13 > 0.3V, DTC2 < 0.2V	ON ”High”	OFF ”High”	ON ”High”
DTC13 < 0.2V, DTC2 > 0.3V	OFF ”Low”	ON ”Low”	OFF ”Low”
DTC13 < 0.2V, DTC2 < 0.2V	OFF ”Low”	OFF ”High”	OFF ”Low”

Pin Description

Pin No	Name	I/O	Description
1	IE2	I	Inverting Input Terminal of Error Amplifier 2 (EA2)
2	OE2	I/O	Output of Error Amplifier 2 (EA2)
3	V_{DD}	I	Supply Voltage
4	OUT2	O	Channel 2 Output
5	OUT3	O	Channel 3 Output
6	OUT1	O	Channel 1 Output
7	GND		Ground
8	SCP	I	Short Circuit Protection
9	V_{REF}	O	Reference Voltage Output
10	DTC13	I	Dead-Time Control of Channel 1, 3 (CH1, CH3)
11	DTC2	I	Dead-Time Control of Channel 2 (CH2)
12	OSC	I	Frequency Setting Capacitor & Resistor Input
13	OE1	I/O	Output of Error Amplifier 1 (EA1)
14	IE1	I	Inverting Input Terminal of Error Amplifier 1 (EA1)
15	IE3	I	Inverting Input Terminal of Error Amplifier 3 (EA3)
16	OE3	I/O	Output of Error Amplifier 3 (EA3)

Absolute Maximum Ratings

Characteristics		Symbol	Value	Unit
Supply Voltage		V_{DD}	8	V
Input Voltage (IE1, IE2, IE3, DTC13, DTC2)		V_I	V_{DD}	V
Output Voltage		V_O	V_{DD} +0.3	V
Output Current	CH1, CH3	I_O	– 41 / + 21	mA
	CH2		– 21 / + 41	mA
Output Peak Current	Sink ($t_w \leqq 2\mu s$, Duty $\leqq 10\%$)	I_{opeak}	+200	mA
	Source ($t_w \leqq 2\mu s$, Duty $\leqq 10\%$)		– 200	
Operating Temperature Range		T_C	– 20 to + 85	°C
Storage Temperature Range		$T_{storage}$	– 45 to + 125	°C

Recommended Operating Conditions

	Symbol	Min	Max	Unit
Supply Voltage, V_{DD}	V_{DD}	2.5	7.0	V
Input Voltage, IE1, IE3	V_{I13}	0.95	1.55	V
Input Voltage, IE2	V_{I2}	0.4	1.0	V
Output Voltage	V_O	0	V_{DD}	V
Oscillator (OSC) Capacitance	C_{OSC}	10	1,800	pF
Oscillator (OSC) Resistance (Note 1)	R_{OSC}	6	8	kΩ
Oscillator (OSC) Frequency	f_{OSC}	50	1,000	kHz
Output Current (CH1, CH3)	I_{O13}		– 40 / + 20	mA
Output Current, (CHl, CH2)	I_{O2}		– 20 / + 40	mA
Output Current of Error Amplifier 1, 2 and 3 (EA1, EA1, EA3)	I_{OE}		60	µA
Operating Temperature	T_C	– 20	85	°C

Note 1: The rise and fall times of oscillator wave form will be equal at OSC resistor (R_{OSC}) =7 kΩ theoretically.

Electrical Characteristics, V_{DD} = 3.3V ; T_C = 25 °C (Unless Otherwise Specified)

Oscillator

Parameter		Test Condition	Min	Typ	Max	Unit
Oscillator Frequency	f_{OSC}	C_{OSC} = 130pF, R_{OSC} = 7 kΩ	400	500	600	kHz
Oscillator Output Voltage at High	V_{OSCH}	C_{OSC} = 130pF, R_{OSC} = 7 kΩ	0.95	1.00	1.05	V
Oscillator Output Voltage at Low	V_{OSCL}	C_{OSC} = 130pF, R_{OSC} = 7 kΩ	0.35	0.40	0.45	V
Frequency Change with V_{DD}	$f_{\Delta V}$	V_{DD} = 2.5V to 7V, C_{OSC} = 130pF, R_{OSC} = 7 kΩ		1	2	%
Frequency Change with Temperature	$f_{\Delta T}$	(Note 2)		5	10	%
Oscillator Output Current	I_{OSC}		– 180	– 200	– 220	µA

Under-Voltage Protection

Parameter		Test Condition	Min	Typ	Max	Unit
Upper Threshold Voltage	V_{UPH}		2.2	2.3	2.4	V
Lower Threshold Voltage	V_{UPL}		2.0	2.1	2.2	V
Hysteresis (V_{UPH} – V_{UPL})	V_{HYS}		0.1	0.2	0.3	V

Short Circuit Protection Control

Parameter		Test Condition	Min	Typ	Max	Unit
Input Threshold Voltage	V_{r1}	CH1, CH3	1.10	1.15	1.20	V
	V_{r2}	CH2	0.20	0.25	0.30	
Latch Reset Threshold Voltage	V_R		0.8	1.5	1.8	V
Short Circuit Detect Threshold Voltage	V_{r3}		1.20	1.25	1.30	V
SCP Terminal Source Current	I_{SCP}		– 1.4	– 2.0	– 2.6	µA

Note 2: The deviation is defined as the difference between the maximum and minimum values obtained over the recommended temperature range (-20 °C to 85 °C).

Electrical Characteristics, V_{DD} = 3.3V; T_C = 25 °C (Unless Otherwise Specified) (Cont.)

Reference Voltage

Parameter		Test Conditions	Min	Typ	Max	Unit
Reference Voltage	V_{REF}	$I_{REF} = -1mA$	1.237	1.250	1.263	V
Short Circuit Output Current	I_{OS}	$V_{REF} = 0$	– 2	– 10	– 30	mA
Input Voltage Regulation	V_{RI}	$I_{REF} = -1mA$, V_{DD} = 2.5V to 7V		2	5	mV
Output Regulation	V_{RO}	I_{REF} = –0.1mA to – 1mA		1	5	mV
Reference Voltage Change with Temperature	$V_{R\Delta}$	$I_{REF} = -1mA$ (Note 3)		15	25	mV

EA (Error Amplifier)

Parameter		Test Condition	Min	Typ	Max	Unit
Input Offset Voltage	V_{IO}	CH1,CH3, Unity Gain			15	mV
Input Bias Current	I_{IB}	CH1,CH3, V_{I13} = 0.95V to 1.55V		±10	±20	nA
		CH2, V_{I2} = 0.4V to 1.0V		±10	±20	
Input Voltage Range	V_{IR}	CH1, CH3	0.95		1.55	V
		CH2	0.4		1.0	
Open-Loop Voltage Gain	A_{VO}	R_{OE} = 200 kΩ		60		dB
Unity-Gain Bandwidth	BW_1			1		MHz
Output Voltage Swing	V_{OS+}	$\Delta V_I = +0.1V$, $I_O = -60\mu A$	1.2			V
	V_{OS-}	$\Delta V_I = -0.1V$, I_O = 0.2mA			0.2	
Output Sink Current	I_{OS+}	$\Delta V_I = -0.1V$, V_O = 0.2V	0.2	1.0		mA
Output Source Current	I_{OS-}	$\Delta V_I = +0.1V$, V_O = 1.2V	– 60	– 100		µA
Input Bias Voltage	V_{r5}	CH2, Unity Gain, T_C = 25 °C	678	700	722	mV
		CH2, Unity Gain	665	700	735	

Note 3: The parameter $V_{R\Delta}$ is defined as the difference between the maximum and minimum values obtained over the recommended temperature range (-20 °C to 85 °C).

Electrical Characteristics, V_{DD} = 3.3V; T_C = 25°C (Unless Otherwise Specified) (Cont.)

Dead-Time Control

Parameter		Test Condition	Min	Typ	Max	Unit
Input Bias Current	$I_{BDT1/3}$	V_{DTC13} = 0.35V to 1.05V			200	nA
	I_{BDT2}	V_{DTC2} = 0.35V to 1.05V		±2	±20	nA
Input Threshold Voltage (DTC 13)	V_{13d0}	Duty = 0%, f_{OSC} = 500kHz	0.3	0.4	0.5	V
	V_{13d100}	Duty = 100%, f_{OSC} = 500kHz	0.9	1.0	1.1	
Input Threshold Voltage (DTC2)	V_{2d0}	Duty = 0%, f_{OSC} = 500kHz	0.3	0.4	0.5	V
	V_{2d100}	Duty = 100%, f_{OSC} = 500kHz	0.9	1.0	1.1	
Channel On / Off Threshold Voltage	V_{r4}		0.2	0.25	0.3	V

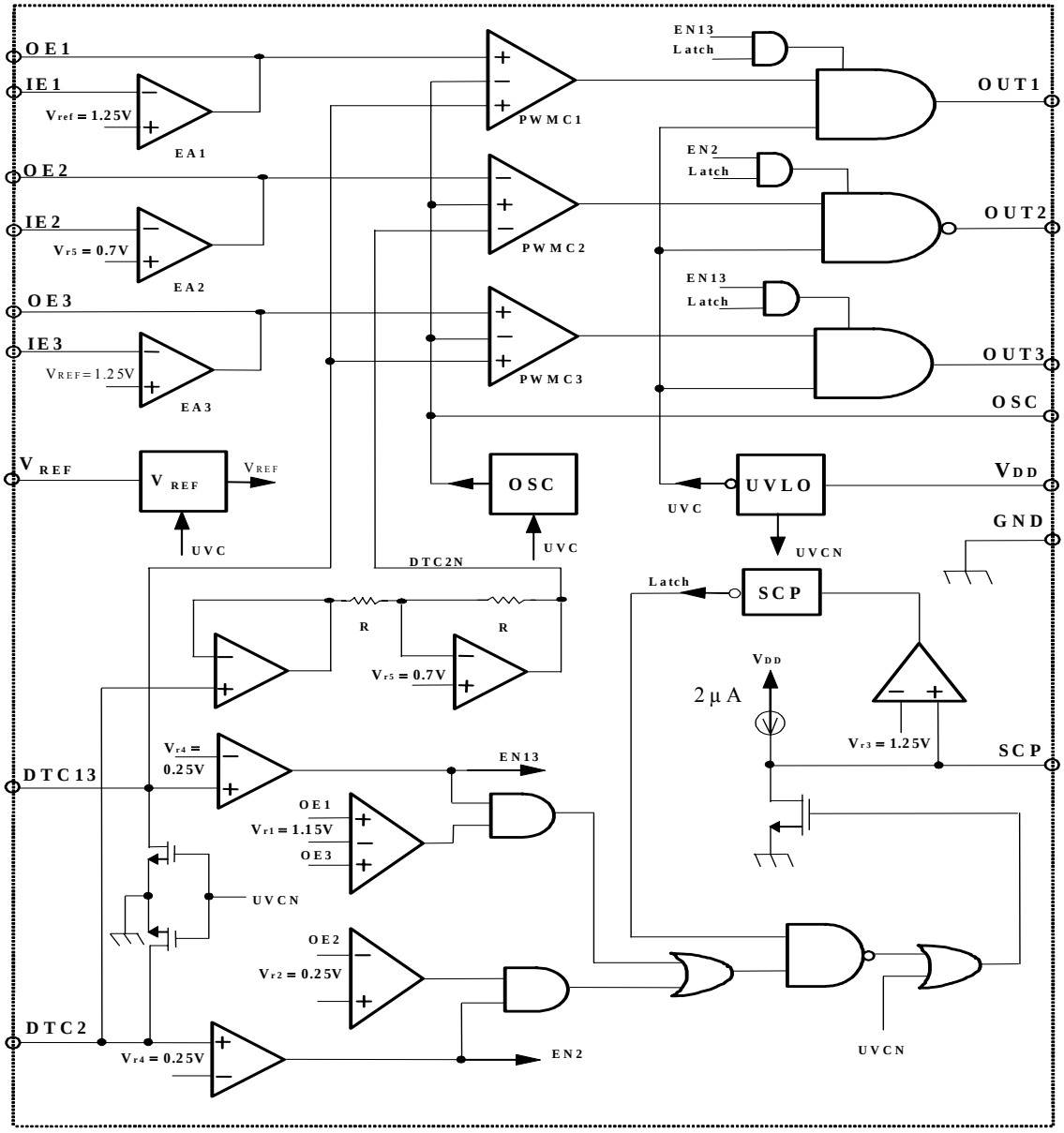
Output Stage

Parameter		Test Condition	Min	Typ	Max	Unit
High-Level Output Voltage	V_{OH}	I_O = –20mA (CH2)	2.90	3.05		V
		I_O = –40mA (CH1, CH3)	1.9	2.2		
Low-Level Output Voltage	V_{OL}	I_O = 20mA (CH1, CH3)		0.2	0.4	V
		I_O = 40mA (CH2)		0.3	0.6	
Rise Time	t_{RISE}	C_L = 1,000pF		130		ns
Fall Time	t_{FALL}	C_L = 1,000pF		50		ns

Operating Current

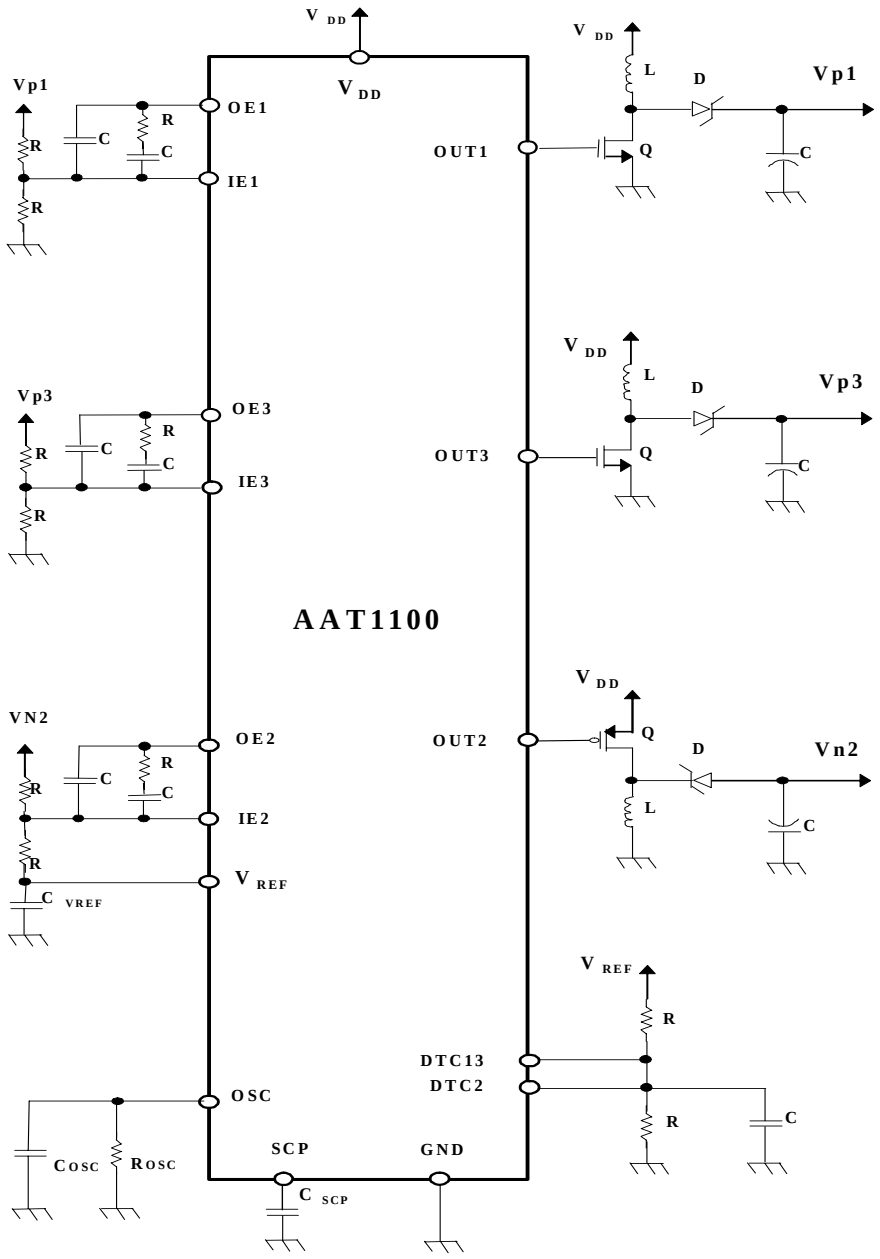
Parameter		Test Condition	Min	Typ	Max	Unit
Supply Current	I_{DD-OFF}	Output "OFF" State		2.5	4.0	mA
	I_{DD-ON}	f_{OSC} = 500 kHz, Duty = 50%, No Load		3.5	5.0	mA

Block Diagram

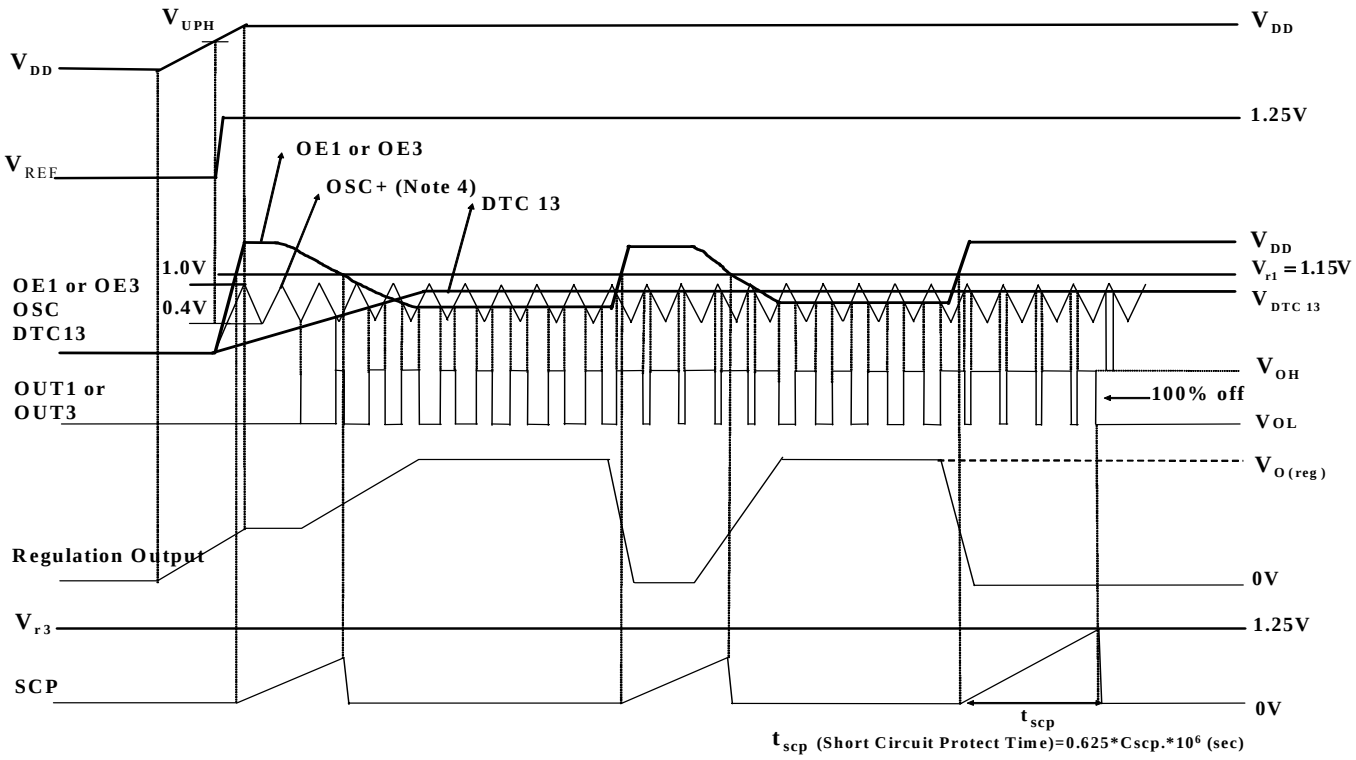


Note: All voltage and current values in block diagram are nominal.

Application Circuit



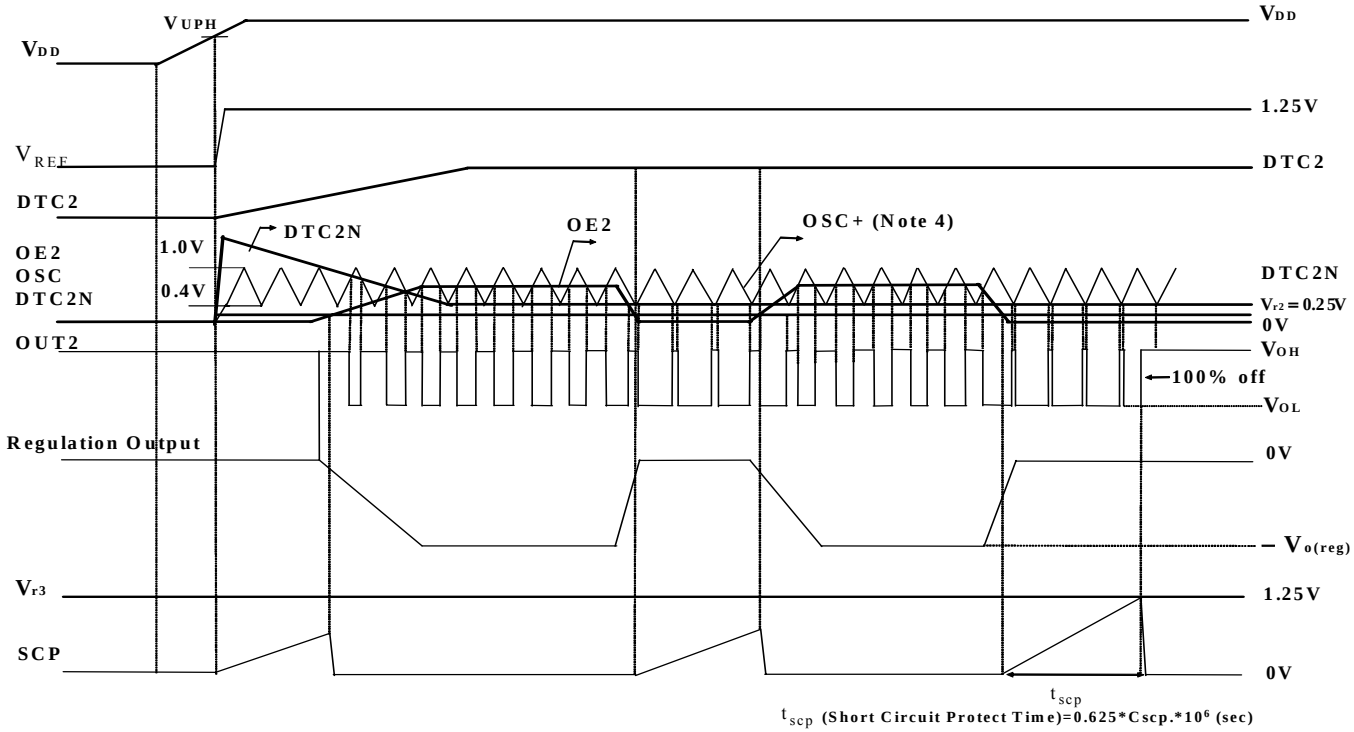
Timing Chart



Timing Chart for CH1 or CH3

Note 4 : + Oscillator wave form is illustrated as a triangle wave form. However it is actually determined by time constant of timing resistor and capacitor connected to OSC terminal.

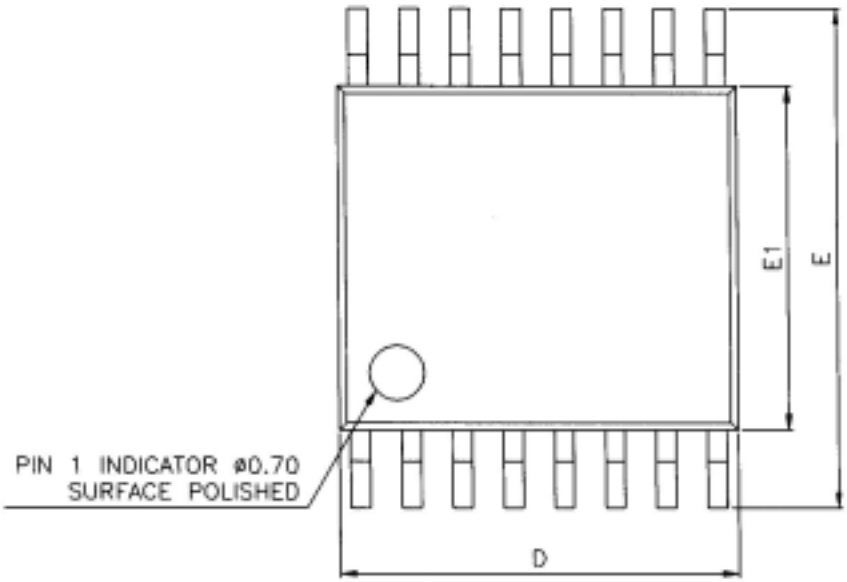
Timing Chart

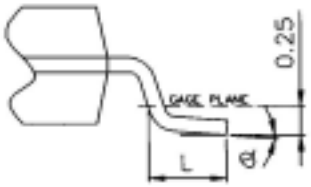


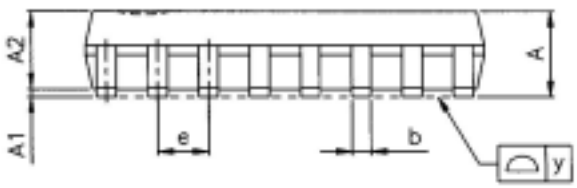
Timing Chart for CH2

Package Dimension

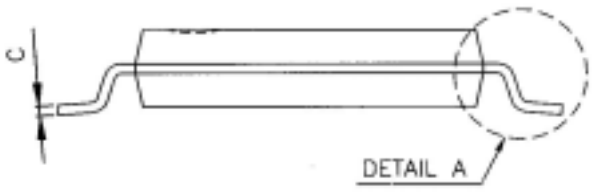
16-PIN TSSOP







Package Dimension (Cont.)

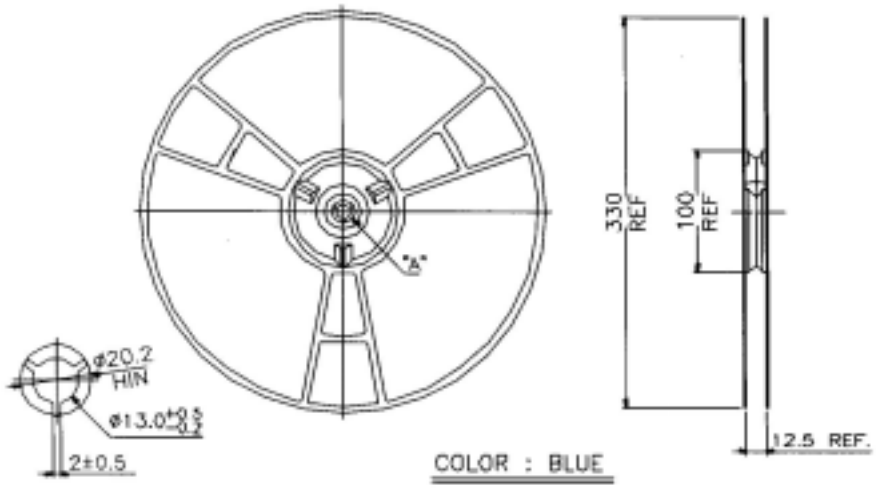


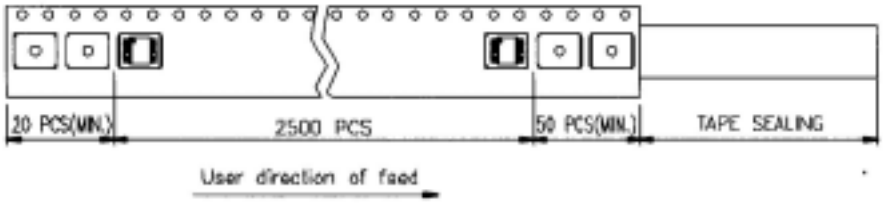
SYMBOLS	DIMENSIONS IN MILLIMETERS			DEMINSIONS IN INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	1.05	1.10	1.20	0.041	0.043	0.047
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	------	1.00	1.05	------	0.039	0.041
b	0.20	0.25	0.28	0.008	0.010	0.011
C	------	0.127	------	------	0.005	------
D	4.900	5.075	5.100	0.1930	0.1998	0.2000
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.170	0.173	0.177
e	------	0.65	------	------	0.026	------
L	0.50	0.60	0.70	0.020	0.024	0.028
y	------	------	0.076	------	------	0.003
θ	0°	4°	8°	0°	4°	8°

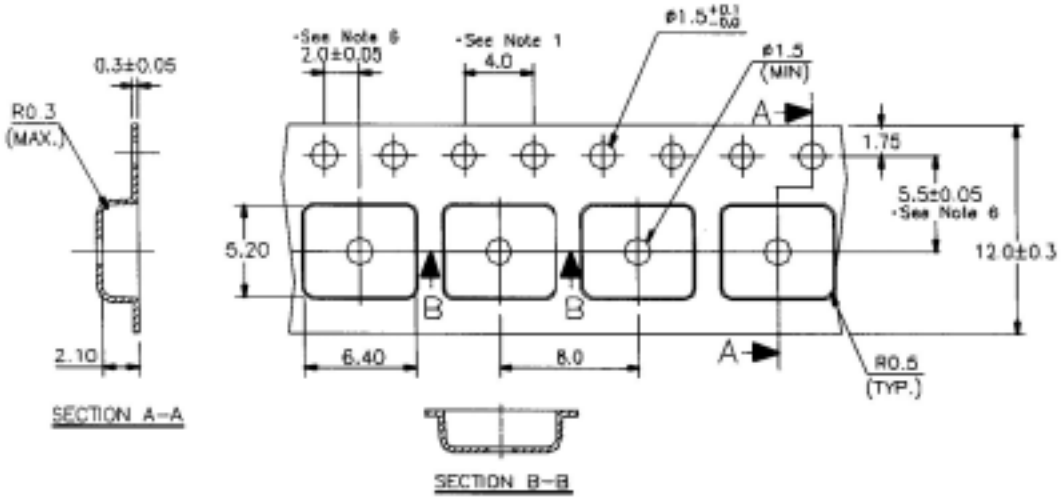
NOTE:

1. CONTROLLING DIMENSION: MILLIMETERS
2. LEAD FRAME MATERIAL: OLIN C7025/EFTEC 64T
3. DIMENSION “D” DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006” [0.15 MILLIMETERS] PER END. DIMENSION “E1” DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010” [0.25 MILLIMETERS] PER SIDE.
4. DIMENSION “b” DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003” [0.08 MILLIMETERS] TOTAL IN EXCESS OF THE “b” DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028” [0.07 MILLIMETERS].
5. TOLERANCE: ± 0.010 [0.25 MILLIMETERS] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT: JEDEC SPEC MO-153.

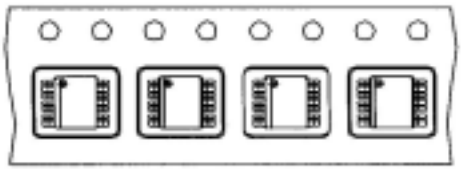
Tape and Reel







Tape and Reel (Cont.)



TSSOP 14L / 16L

NOTE:

1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2 MILLIMETERS.
2. CAMBER NOT TO EXCEED 1 MILLIMETER IN 100 MILLIMETERS.
3. MATERIAL: ANTI-STATIC BLACK ADVANTEK POLYSTYRENE.
4. A_0 AND B_0 MEASURED ON A PLANE 0.3 MILLIMETERS ABOVE THE BOTTOM OF THE POCKET.
5. K_0 MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE POCKET TO THE TOP SURFACE OF THE CARRIER.
6. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.

Part Marking

TSSOP16 Top Marking

AAT1100
XXXXXX

TSSOP16 Back Marking

YYWW

Ordering Information