



Details are subject to change without notice

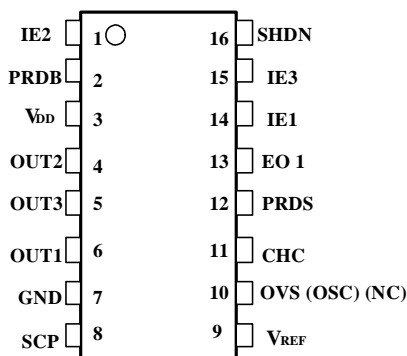
TRIPLE OUTPUT TFT LCD PWM CONTROLLER

Features

- Complete PWM Power Control Circuitry
- Precision Reference: $1.25V \pm 1\%$ ($25^\circ C$)
- Low Operating Voltage: 2.5V to 6.5V
- Under-Voltage Lockout Protection
- 5V or 3.3V Selectable Over Voltage Lockout Protection (AAT1101/A only)
- AAT1101/AAT1101A/AAT1101C: 500kHz Fixed
- AAT1101B: 50k~1MHz Programmable
- Internal Power Up Sequence Control
- Totem Pole Output
- Output Short Circuit Protection
- Low Dissipation Current: 2.5mA
($f=500kHz$, Duty=50%)

Pin Configuration

TOP VIEW



(TSSOP-16 PACKAGE)

General Description

The AAT1101 series provide an integrated triple-channel pulse width modulation (PWM) solution for the power supply of LCD displays. These devices offer system engineers the flexibility to tailor-make the power supply circuitry for specific applications. Each channel contains its own error amplifier, PWM comparator, dead-time control (DTC) and output driver. The under-voltage protection, over voltage protection, power sequence control, shutdown control circuit, oscillator, short circuit protection, and voltage reference circuits are the common features of the three channels.

The AAT1101 series contain two exclusive boost circuits at CH1, CH3 and an exclusive buck_boost circuit at CH2. AAT1101's Power Up sequence initiates at CH1 then CH2 and finally CH3. AAT1101A/C's Power Up sequence acts in the order of CH2, CH3, and then CH1. AAT1101B's Power Up sequence starts from CH2, CH1, and then CH3. At the completion of the Power Up sequencing, the SCP pin stays low and enters the Wait State of short circuit protection. Power Up sequencing delay and short circuit protection delay are set by connecting a capacitor to the SCP pin. Furthermore, these devices can operate with supply voltage ranging from 2.5V to 6.5V and function efficiently in an environment with low power supply. With a minimum number of external components, the AAT1101 series offer a simple and cost effective solution for TFT LCD.



Pin Description

Pin #	Name	I/O	Description
1	IE2	I	Inverted Input of Error Amplifier 2 (EA2)
2	PRDB	O	Power Ready Output
3	V _{DD}	I	Supply Voltage
4	OUT2	O	Channel 2 (CH2) Output
5	OUT3	O	Channel 3 (CH3) Output
6	OUT1	O	Channel 1 (CH1) Output
7	GND		Ground
8	SCP	I	Short Circuit Protection
9	V _{REF}	O	Reference Voltage Output
10*	OVS	I/O	3.3V or 5.0V Over Voltage Selection and Over Voltage Output
10**	OSC	I/O	Frequency Setting Capacitor & Resistor Input
10***	NC		NC
11	CHC	O	Channel Control
12	PRDS	I	Power Ready Set
13	EO1	I/O	Feedback Input of Error Amplifier 1 (EA1)
14	IE1	I	Inverted Input of Error Amplifier 1 (EA1)
15	IE3	I	Inverted Input of Error Amplifier 3 (EA3)
16	SHDN	I	Shutdown Control

* : AAT1101A only

** : AAT1101B only

*** : AAT1101C only

Absolute Maximum Ratings

CHARACTERISTICS		SYMBOL	VALUE	UNIT
Supply Voltage		V _{DD}	8	V
Input Voltage (IE -)		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 2 μs, Duty 10%)	I _{opeak}	+200	mA
	Source (t _w 2 μs, Duty 10%)		-200	
Operating Free-Air Temperature Range		T _C	-20 to +85	°C
Storage Temperature Range		T _{storage}	-45 to +125	°C

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**Recommended Operating Conditions**

	Symbol	Min	Typ	Max	Unit
Supply Voltage, V_{DD} (with R_{OVS})	V_{DD}	2.5	5.0	5.7	V
Supply Voltage, V_{DD} (without R_{OVS})	V_{DD}	2.5	3.3	3.8	V
Supply Voltage, V_{DD} (AAT1101B/C Only)	V_{DD}	2.5	3.3	6.5	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
Output Current, I_{out1} , I_{out3}	I_{O13}	-	-	-40/+20	mA
Output Current, I_{out2}	I_{O2}	-	-	-20/+40	mA
Output Current of Error Amplifier	I_{OE}	-	-	60	μ A
Operating Free-Air Temperature	T_C	-20	-	85	$^{\circ}$ C



Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (See Note 1)

Oscillator : (AAT1101/AAT1101A/AAT1101C)

Parameter		Test Condition	Min	Typ	Max	Unit
Frequency	f_{OSC}	$T_C = 25^\circ C$	400	500	600	kHz
Frequency Changes with T_C	$f_{\Delta T}$		-	5	10	%
Maximum Duty Cycle	T_{xon}		70	85	95	%

Oscillator : (AAT1101B only)

Parameter		Test Condition	Min	Typ	Max	Unit
Frequency	f_{OSC}	$C_{OSC} = 130pf,$ $R_{OSC} = 7k\Omega$	400	500	600	kHz
“H” Level Output Voltage	V_{OSCH}	$C_{OSC} = 130pf,$ $R_{OSC} = 7k\Omega$	0.95	1.00	1.05	V
“L” Level Output Voltage	V_{OSCL}	$C_{OSC} = 130pf,$ $R_{OSC} = 7k\Omega$	0.35	0.40	0.45	V
Frequency Change with V_{DD}	$f_{\Delta V}$	$V_{DD} = 2.5V$ to $6.5V,$ $T_C = 25^\circ C$ $C_{OSC} = 130pf,$ $R_{OSC} = 7k\Omega$	-	1	2	%
Frequency Changes with T_C	$f_{\Delta T}$	-	-	5	10	%
Output Source Current	I_{OSC}	-	-220	-200	-180	μA



Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (Cont.)

Under Voltage (UV) and Over Voltage (OV) Protection

Parameter		Test Condition	Min	Typ	Max	Unit
UV Upper Threshold Voltage	V_{UPH}	$T_C = 25^\circ C$, AAT1101/A/B	2.1	2.3	2.5	V
		$T_C = 25^\circ C$, AAT1101C	2.0	2.2	2.4	V
UV Lower Threshold Voltage	V_{UPL}	$T_C = 25^\circ C$, AAT1101/A/B	1.9	2.1	2.3	V
		$T_C = 25^\circ C$, AAT1101C	1.7	1.87	2.05	V
UV Hysteresis ($V_{UPH} - V_{UPL}$)	V_{HYS}	$T_C = 25^\circ C$, AAT1101/A/B	0.1	0.2	0.3	V
		$T_C = 25^\circ C$, AAT1101C	0.18	0.33	0.48	V
OV 3.3V Threshold Voltage**	V_{OP33}	$T_C = 25^\circ C$	3.8	4.1	4.4	V
OV 5V Threshold Voltage**	V_{OP5}	$T_C = 25^\circ C$, OVS connects a 56 k Ω resistor to V_{DD}	5.7	6.1	6.5	V

** : AAT1101/AAT1101A only

Shutdown Control

Parameter	Test Condition	Min	Typ	Max	Unit
Shutdown Release Input Voltage		2.0	-	-	V
Shutdown Enable Input Voltage		-	-	0.5	V

Short Circuit Protection Control

Parameter		Test Condition	Min	Typ	Max	Unit
Input Threshold Voltage	V_{r1}	CH1 (EO1)	1.10	1.15	1.20	V
	V_{r1}	CH3 (IE3)	1.20	1.25	1.30	V
	V_{r2}	CH2 (IE2)	0.67	0.70	0.73	V
Latch Reset Voltage by V_{DD}	V_{R_VDD}	$T_C = 25^\circ C$	0.8	1.5	1.8	V
Latch Reset Voltage by SHDN	V_{R_SHDN}	$T_C = 25^\circ C$	-	-	0.5	V
Short-Circuit Detection Threshold Voltage	V_{r3}		1.20	1.25	1.30	V
SCP Terminal Source Current	I_{SCP}		-2.6	-2.0	-1.4	μA



Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (Cont.)

Power Ready Output

Parameter		Test Condition	Min	Typ	Max	Unit
Power Ready Threshold Voltage	V_{PRTH}	$T_C = 25\text{ }^\circ\text{C}$	1.18	1.28	1.38	V
Power Ready Source Current	I_{PRTH}		-5.2	-4.0	-2.8	μA

Power-Up Sequence Delay

Parameter		Test Condition	Min	Typ	Max	Unit
Under Voltage - Power Ready	t_{PR}	$t_{PR} = (3.2 \times 10^5) C_{PRDS}$	-	t_{PR}	-	s
Under Voltage - CH1 Output	t_{PR}		-	t_{PR}	-	s
CH1 Output - CH2 Output	t_{CH1}	$t_{CH1} = (19531.25) C_{SCP}$	-	t_{CH1}	-	s
CH2 Output - CH3 Output	t_{CH2}		-	$0.8 t_{CH1}$	-	s
CH3 Output - CHC Set High	t_{CH3}		-	$0.8 t_{CH1}$	-	s
CH3 Output - SCP Ready to Protect	t_{CH3}		-	$0.8 t_{CH1}$	-	s
SCP Enable Time	t_{SCP}		-	$32 t_{CH1}$	-	s



Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (Cont.)

Power-Up Sequence Delay (for AAT1101A/AAT1101C)

Parameter		Test Condition	Min	Typ	Max	Unit
Under Voltage - Power Ready	t_{PRA}	$t_{PR} = (3.2 \times 10^5) C_{PRDS}$	-	t_{PRA}	-	s
Under Voltage - CH2 Output	t_{PRA}		-	t_{PRA}	-	s
CH2 Output - CH3 Output	t_{CH2A}	$t_{CH2} = (19531.25) C_{SCP}$	-	t_{CH2A}	-	s
CH3 Output - CH1 Output	t_{CH3A}		-	$0.8 t_{CH2A}$	-	s
CH1 Output - CHC Set High	t_{CH1A}		-	$0.8 t_{CH2A}$	-	s
CH1 Output - SCP Ready to Protect	t_{CH1A}		-	$0.8 t_{CH2A}$	-	s
SCP Enable Time	t_{SCPA}		-	$32 t_{CH2A}$	-	s

Power-Up Sequence Delay (for AAT1101B)

Parameter		Test Condition	Min	Typ	Max	Unit
Under Voltage - Power Ready	t_{PRB}	$t_{PR} = (3.2 \times 10^5) C_{PRDS}$	-	t_{PRB}	-	s
Under Voltage - CH2 Output	t_{PRB}		-	t_{PRB}	-	s
CH2 Output - CH1 Output	t_{CH2B}	$t_{CH2} = (19531.25) C_{SCP}$	-	t_{CH2B}	-	s
CH1 Output - CH3 Output	t_{CH3B}		-	$0.8 t_{CH2B}$	-	s
CH3 Output - CHC Set Hi	t_{CH1B}		-	$0.8 t_{CH2B}$	-	s
CH3 Output - SCP Ready to Protect	t_{CH1B}		-	$0.8 t_{CH2B}$	-	s
SCP Enable Time	t_{SCPB}		-	$32 t_{CH2B}$	-	s



Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (Cont.)

Reference Voltage

Parameter		Test Conditions	Min	Typ	Max	Unit
Reference Voltage	V_{REF}	$I_{REF} = -1mA, T_C = 25^\circ C$	1.237	1.250	1.263	V
Short-Circuit Output Current	I_{OS}	$V_{REF} = 0$	-30	-10	-2	mA
Input Voltage Regulation	V_{RI}	$I_{REF} = -1mA, V_{DD} = 2.5V \text{ to } 6.5V$	-	2	5	mV
Output Regulation	V_{RO}	$I_{REF} = -0.1mA \text{ to } -1mA$	-	1	5	mV
Reference Voltage Change with Temperature	V_{RT}	$I_{REF} = -1mA$ (Note 2)	-	15	25	mV

EA1 (Error Amplifier for Channel 1)

Parameter		Test Condition	Min	Typ	Max	Unit
Input Offset Voltage	V_{IO}	Unity Gain	-	-	15	mV
Input Bias Current	I_{IB}	$V_I = 0.95V \text{ to } 1.55V$	-	± 10	± 20	nA
Input Voltage Range	V_{IR}		0.95	-	1.55	V
Open-Loop Voltage Gain	A_{VO}	$R_{FB} = 200k$	-	60	-	dB
Unity-Gain Bandwidth	BW_1		-	1	-	MHz
Output Voltage Swing	V_{OS+}	$V_{ID} = 0.1V, I_O = -60\mu A$	1.2	-	-	V
	V_{OS-}	$V_{ID} = -0.1V, I_O = 0.2mA$	-	-	0.2	
Output Sink Current	I_{OS+}	$V_{ID} = -0.1V, V_O = 0.2V$	0.2	1.0	-	mA
Output Source Current	I_{OS-}	$V_{ID} = 0.1V, V_O = 1.2V$		-100	-60	μA
CH2 Input Reference Voltage	V_{r4}	$T_C = 25^\circ C$	678	700	722	mV

**Electrical Characteristics, $V_{DD} = 3.3V$ (Unless Otherwise Specified) (Cont.)****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}	$C_L = 1000pF$		130		ns
Fall time	t_{FALL}	$C_L = 1000pF$		50		ns

Operating Current

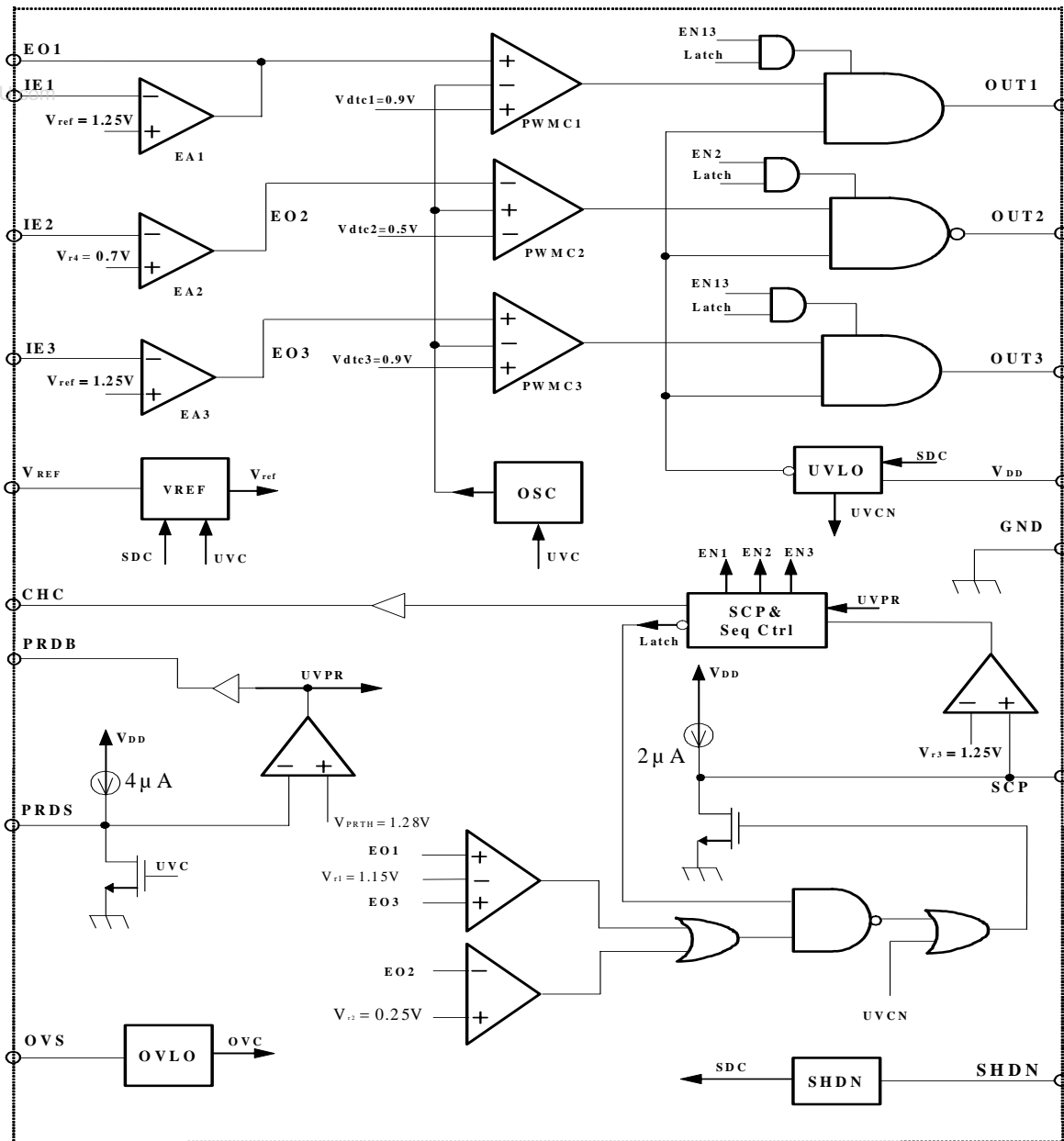
Parameter		Test Condition	Min	Typ	Max	Unit
Supply Current	I_{DD-ON}	Duty = 50%, No Load	-	2.5	4.5	mA
	I_{SHDN}		-	-	20	μA

Note 1: Typical values of all parameters except for V_{RT} (dev) and $f_{\Delta T}$ are specified at $T_C = 25^\circ C$.

Note 2: The deviation parameter V_{RT} (dev) is defined as the difference between the maximum and minimum values obtained over the recommended free-air temperature range ($-20^\circ C$ to $85^\circ C$).

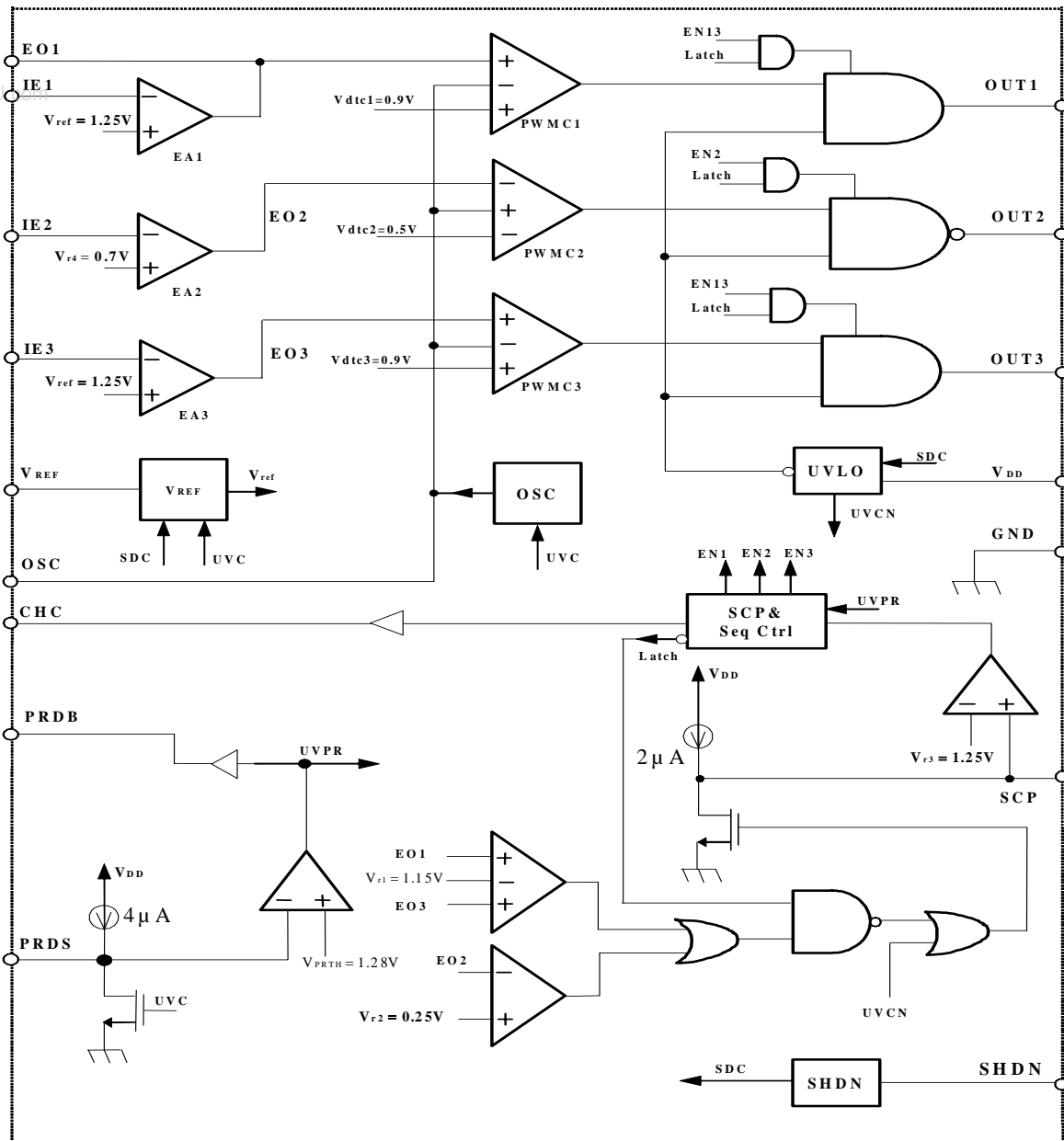


Block Diagram
AAT1101/AAT1101A Only



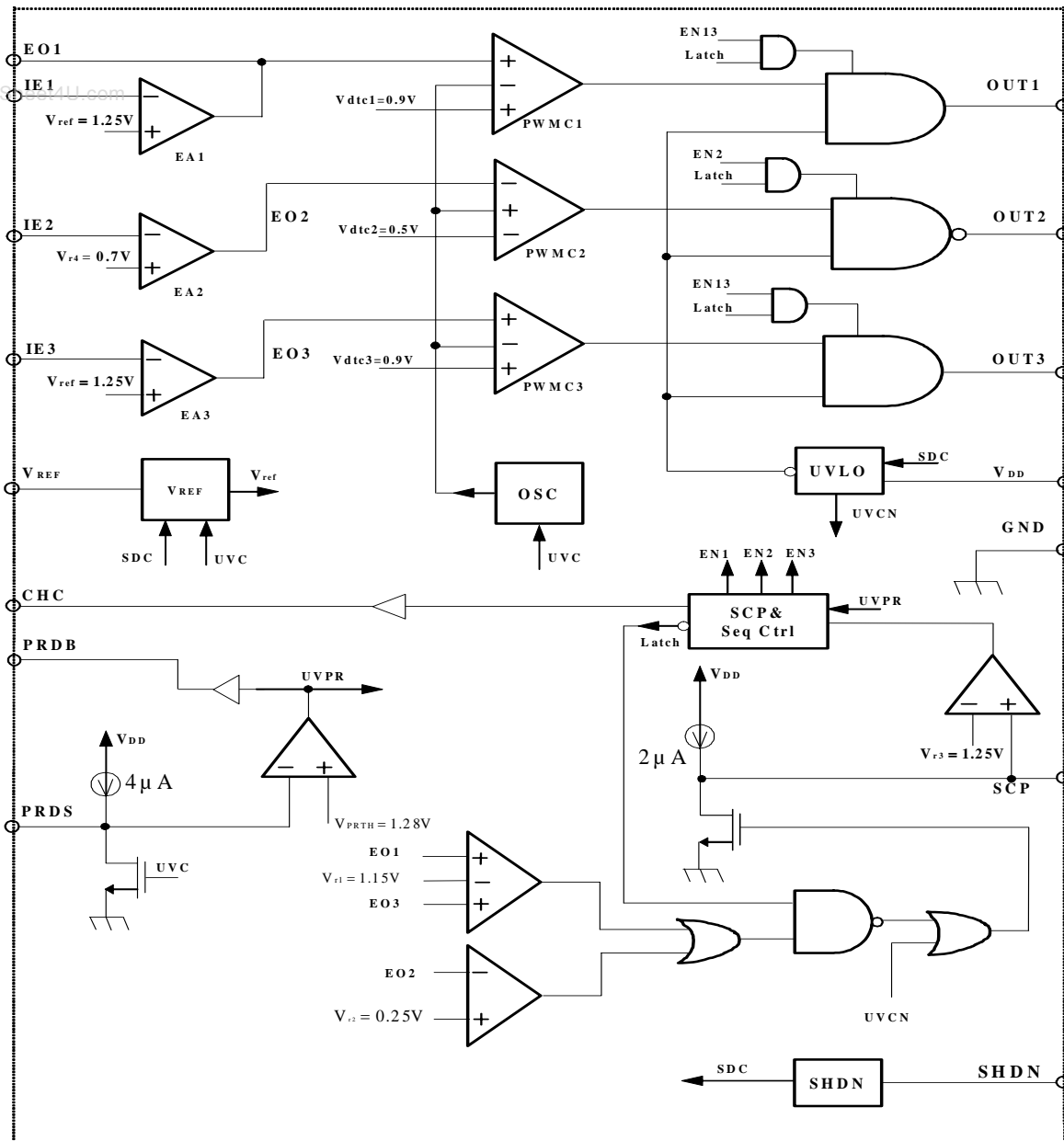


Block Diagram
AAT1101B Only





Block Diagram
AAT1101C Only



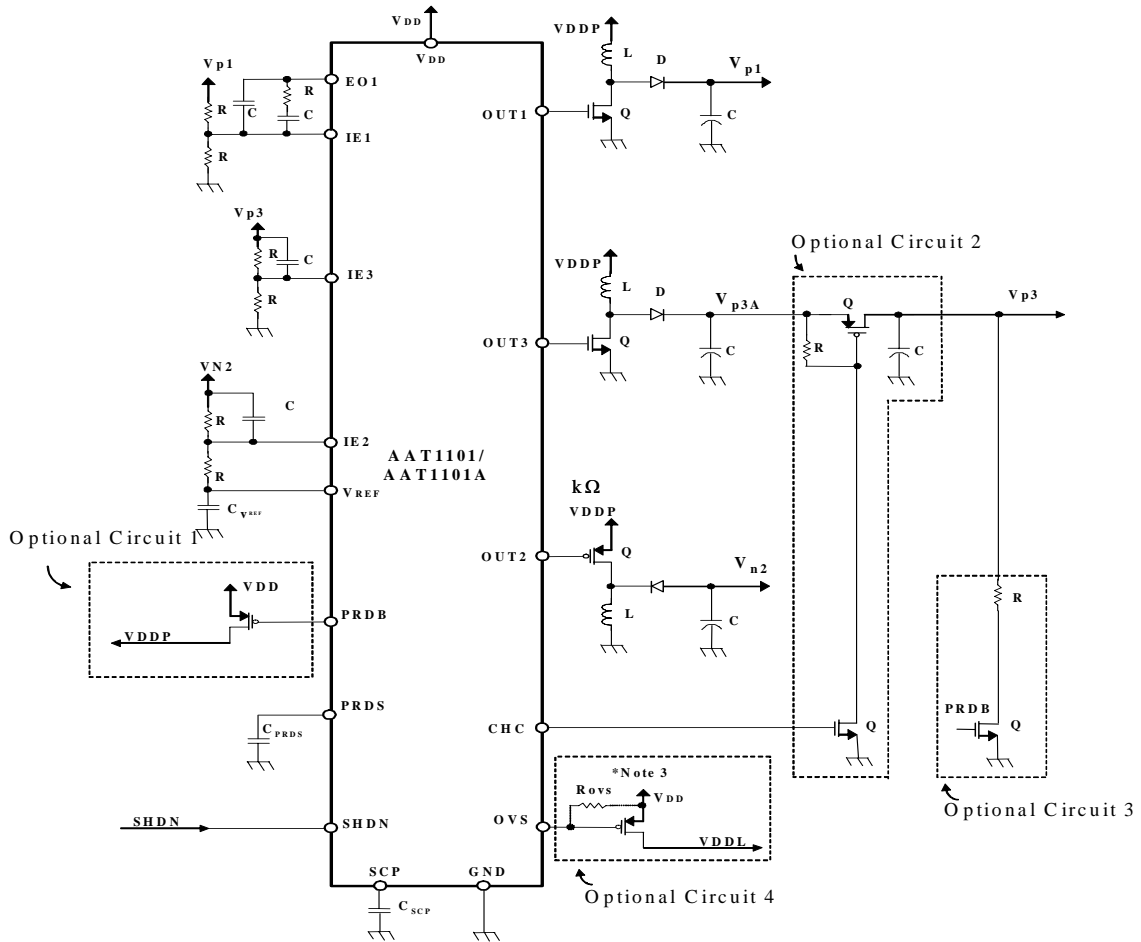


Application Circuit

AAT1101/AAT1101A Only

kΩ

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*Note 3: $V_{DD} = 5V$, connects a $R_{OVS} = 56 k\Omega$ to V_{DD}

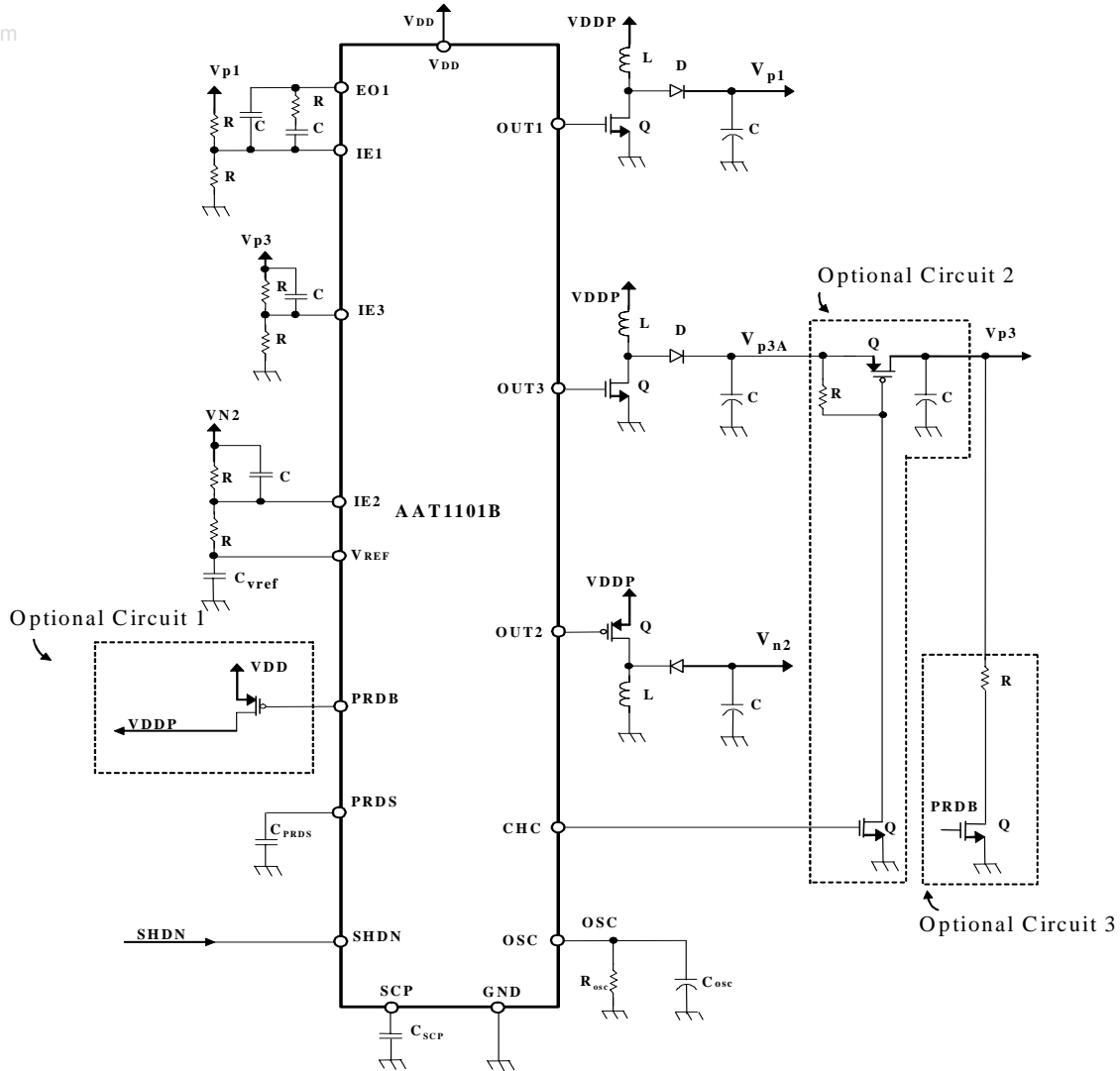
$V_{DD} = 3.3V$, connects no resistor to V_{DD}

Note: All voltage and current values in block diagram (for AAT1101/AAT1101A) are nominal.



Application Circuit
AAT1101B Only

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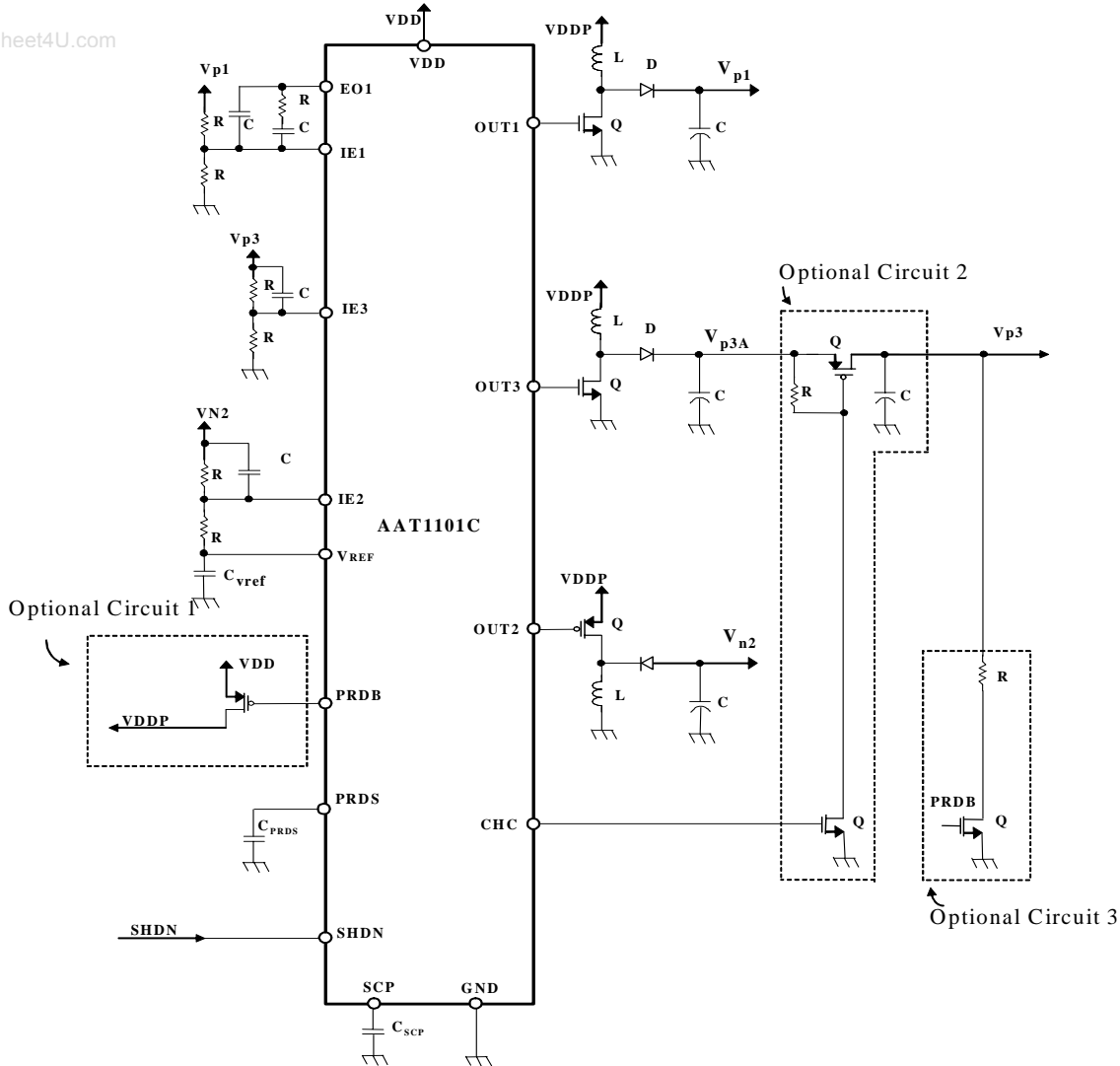


All voltage and current values in block diagram are nominal.



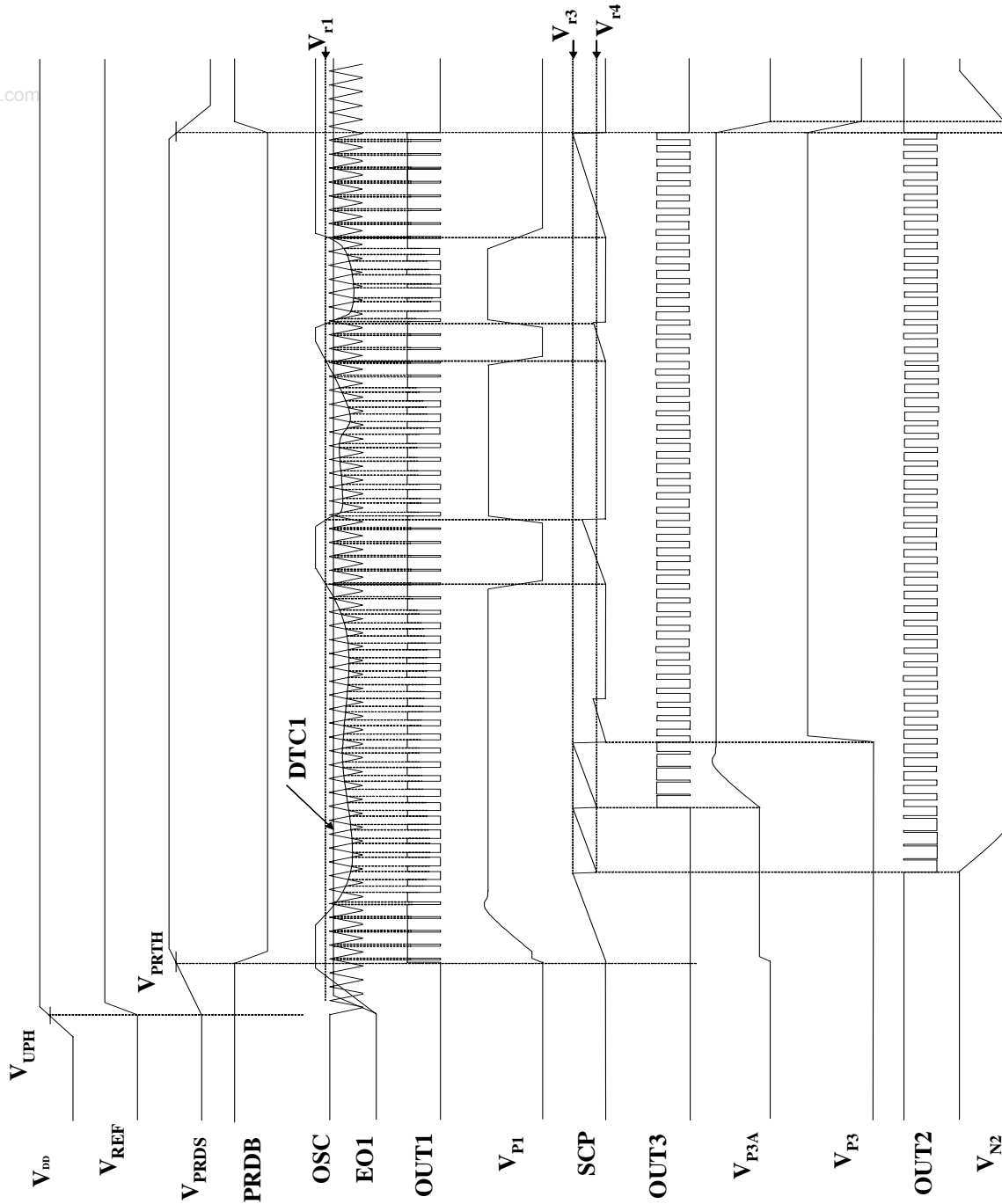
Application Circuit
AAT1101C Only

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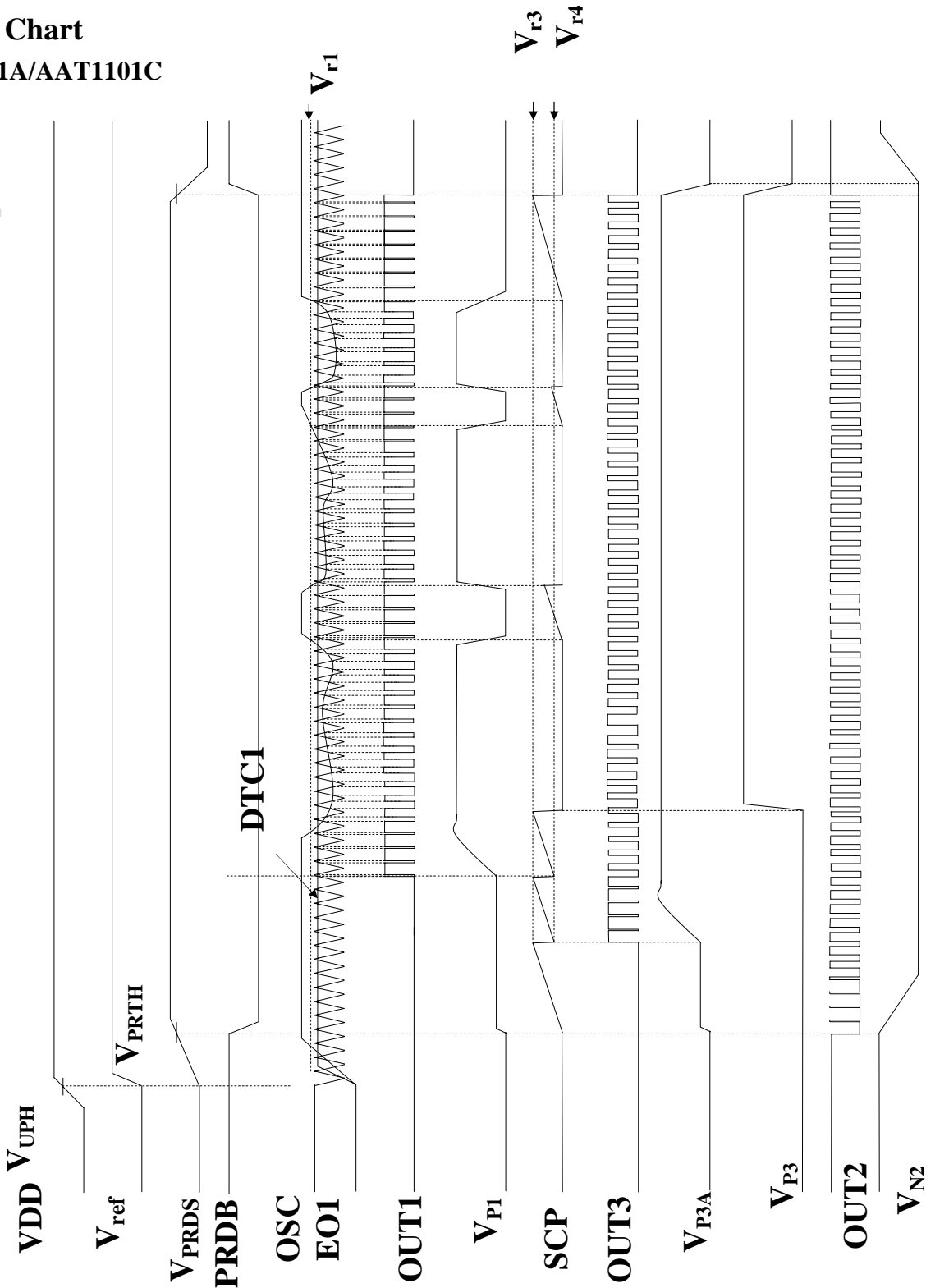


Timing Chart
AAT1101





Timing Chart
AAT1101A/AAT1101C

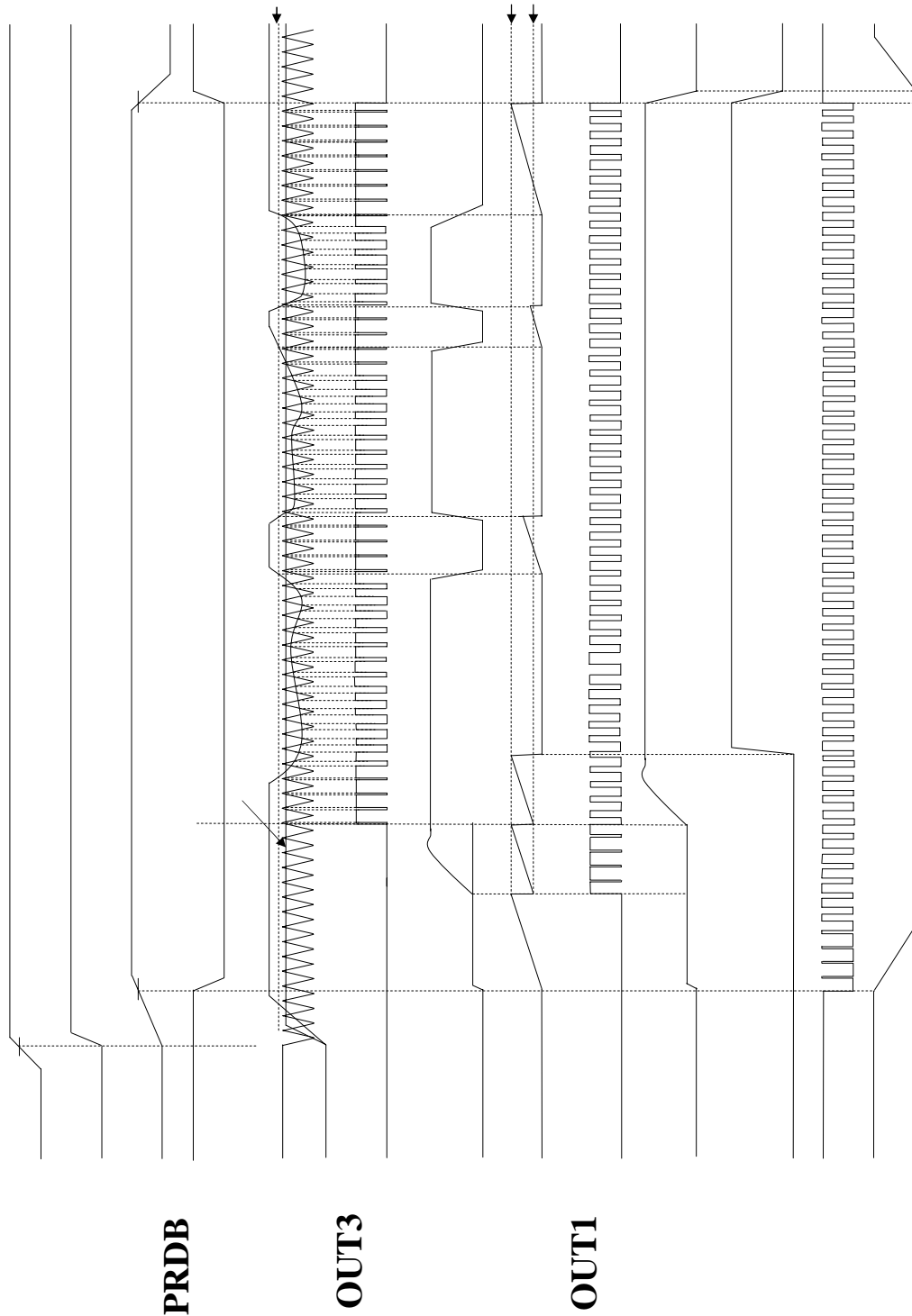


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Timing Chart
AAT1101B

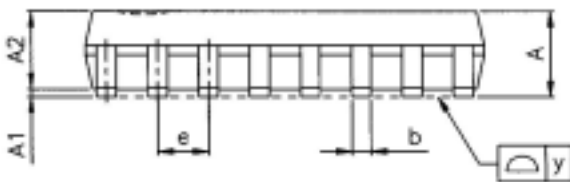
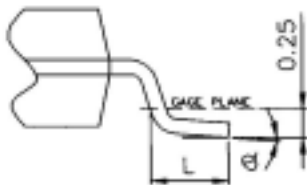
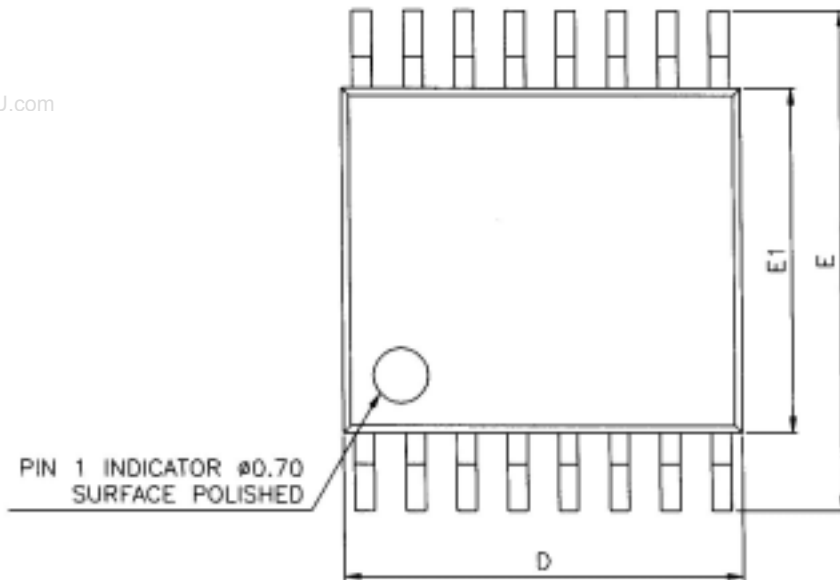
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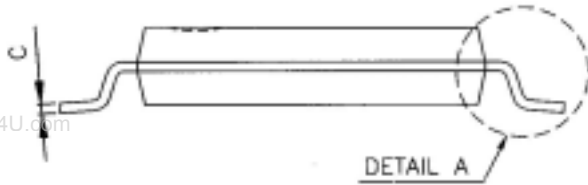
PACKAGE DIMENSION
16-PIN TSSOP

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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.

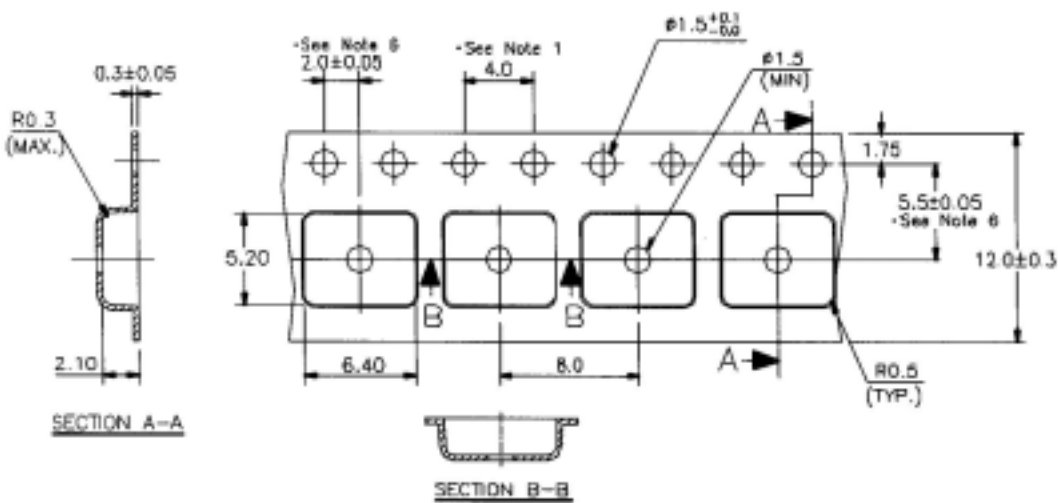
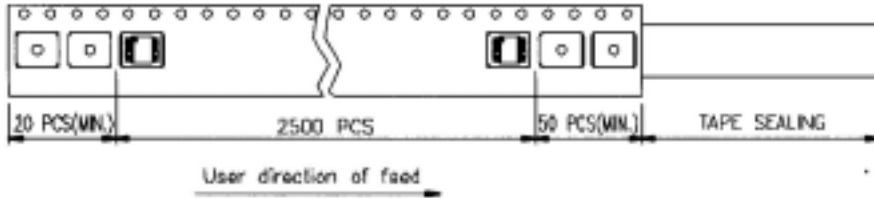
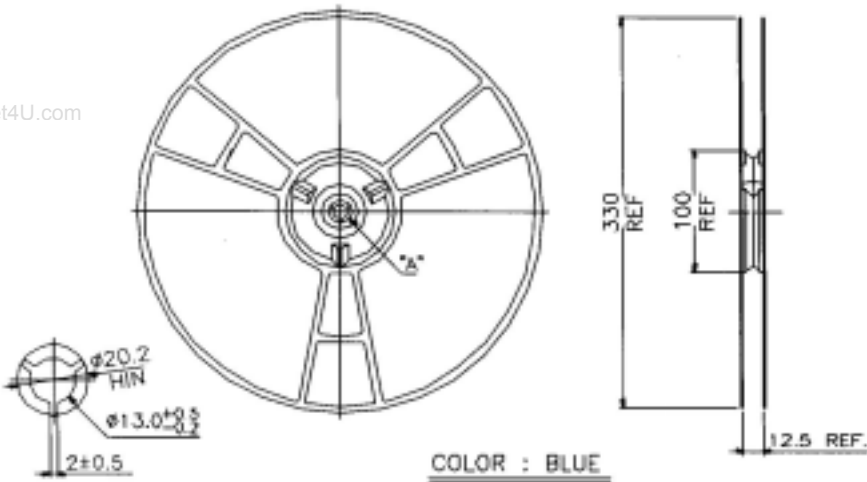


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AAT1101 Series

TAPE AND REEL

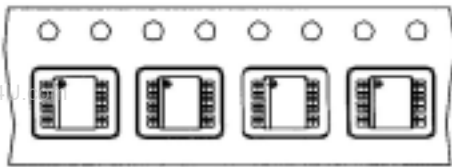
PACKING METHOD: 2,500PCS/REEL, 1 REEL/BOX



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TAPE AND REEL (CONT.)



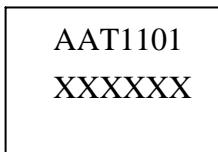
TSSOP 14L / 16L

NOTE:

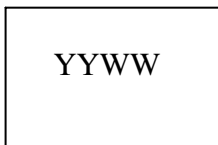
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ± 0.2 MILLIMETERS.
2. CAMBER NOT TO EXCEED 1 MILLIMETER IN 100 MILLIMETERS.
3. MATERIAL: ANTI-STATIC BLACK ADVANTEK POLYSTYRENE.
4. A_0 AND B_0 MEASURED ON A PLANE 0.3 MILLIMETERS ABOVE THE BOTTOM OF THE POCKET.
5. K_0 MEASURED FROM A PLANE ON THE INSIDE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



TSSOP16 BACK MARKING





ORDERING INFORMATION

AAT xxxxx-xx-x

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AAT Part Number

Package Code 2
T=Taping Reel
Blank=Tube or Tray

Package Code 1
Tssop16: T1

Remark:
T=Taping Reel
PS.
Tssop16→3,000pcs/reel
Blank=Tube
PS.
Tssop16→56pcs/tube