



Advanced Analog Technology, Inc.

AAT1403A

Details are subject to change without notice

SIX-CHANNEL DIGITAL STILL CAMERA POWER SUPPLY

FEATURES

- Complete PWM Power Control Circuitry
- Input Voltage Range: 1.4V to 6.5V
- Low Start-Up Voltage: 1.4V (CH6)
- Separate On/Off Control for CH1~CH6
- Supports Synchronous Boost Rectification (CH6)
- Supports Synchronous Buck Rectification (CH1, 5)
- Supports Boost Conversion (CH2, 4)
- Supports White LED Driver (CH4)
- Supports Inverting Conversion (CH3)
- Totem Pole Output
- Short Circuit Protection
- VQFN40 and LQFP48 Package
- Oscillator Frequency: 500 kHz ($\pm 15\%$)

APPLICATIONS

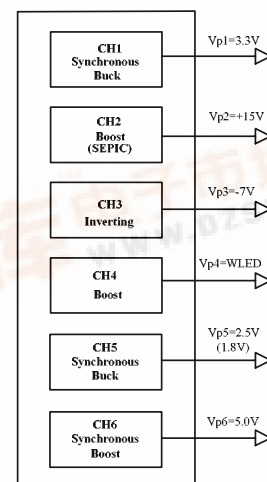
- Digital Cameras
- CCD Imaging Devices
- Camcorders

GENERAL DESCRIPTION

The AAT1403A provides an integrated six-channel pulse-width-modulation (PWM) solution for the power supply of DC-DC converter; this device offers system engineer flexibility to tailor-make the power supply circuitry for specific applications. Each channel contains its own error amplifier, PWM comparator, dead-time control and output driver. The under-voltage protection, oscillator, short circuit protection and voltage reference circuit are the common features for the six channels.

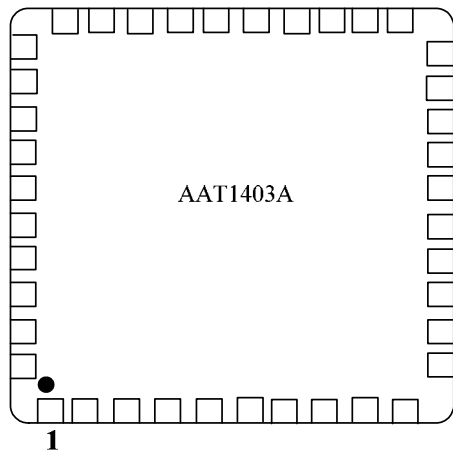
In addition to two boost conversions and one inverting conversion, AAT1403A also has three synchronous rectifiers.

AAT1403A

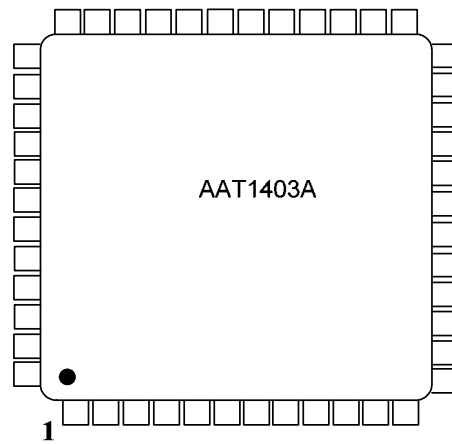




PIN CONFIGURATION



(VQFN-40)



(LQFP-48)

FUNCTION TABLE

Condition	Channel Status					
	CH1	CH2	CH3	CH4	CH5	CH6
SD –						
SD1= “Lo”	Off					
SD1= “Hi”	On					
SD2= “Lo”		Off				
SD2= “Hi”		On				
SD3= “Lo”			Off			
SD3= “Hi”			On			
SD4= “Lo”				Off		
SD4= “Hi”				On		
SD5= “Lo”					Off	
SD5= “Hi”					On	
SD6= “Lo”						Off
SD6= “Hi”						On



PIN DESCRIPTION (VQFN-40)

Pin No	Name	I/O	Function
1	SD1	I	ON/OFF Control for Channel 1 (CH1)
2	SD5	I	ON/OFF Control for Channel 5 (CH5)
3	SD6	I	ON/OFF Control for Channel 6 (CH6)
4	IE1	I	Inverted Input for Error Amplifier 1 (EA1)
5	IE5	I	Inverted Input for Error Amplifier 5 (EA5)
6	IE6	I	Inverted Input for Error Amplifier 6 (EA6)
7	DTC1	I	Dead Time Control of Channel 1 (CH1)
8	OE1	O	Output for Error Amplifier 1 (EA1)
9	DTC5	I	Dead Time Control of Channel 5 (CH5)
10	OE5	O	Output for Error Amplifier 5 (EA5)
11	DTC6	I	Dead Time Control of Channel 6 (CH6)
12	OE6	O	Output for Error Amplifier 6 (EA6)
13	VB	O	Reference Voltage 2.77V Output
14	GND	P	Ground
15	V _{DD}	P	Power Supply
16	V _{REF}	O	Reference Voltage 1.26V Output
17	SCP	-	Short Circuit Protect Capacitor Connection Pin
18	SD4	I	ON/OFF Control for Channel 4 (CH4)
19	SD3	I	ON/OFF Control for Channel 3 (CH3)
20	SD2	I	ON/OFF Control for Channel 2 (CH2)
21	IE4A	I	Inverted Input 2 for Error Amplifier 4 (EA4)
22	IE4	I	Inverted Input for Error Amplifier 4 (EA4)
23	IE3	I	Inverted Input for Error Amplifier 3 (EA3)
24	IE2	I	Inverted Input for Error Amplifier 2 (EA2)
25	OE4	O	Output for Error Amplifier 4 (EA4)
26	OE3	O	Output for Error Amplifier 3 (EA3)
27	OE2	O	Output for Error Amplifier 2 (EA2)
28	DTC4	I	Dead Time Control of Channel 4 (CH4)
29	DTC3	I	Dead Time Control of Channel 3 (CH3)
30	DTC2	I	Dead Time Control of Channel 2 (CH2)
31	OUT2	O	CH2 Totem Pole Type Output
32	OUT3	O	CH3 Totem Pole Type Output
33	OUT4	O	CH4 Totem Pole Type Output
34	OUT6_2	O	CH6 Synchronous Rectifier Side Output
35	PVDD	P	Output Buffer Power Supply
36	OUT6_1	O	CH6 Totem Pole Type Output
37	OUT5_1	O	CH5 Totem Pole Type Output
38	OUT5_2	O	CH5 Synchronous Rectifier Side Output
39	OUT1_1	O	CH1 Totem Pole Type Output
40	OUT1_2	O	CH1 Synchronous Rectifier Side Output

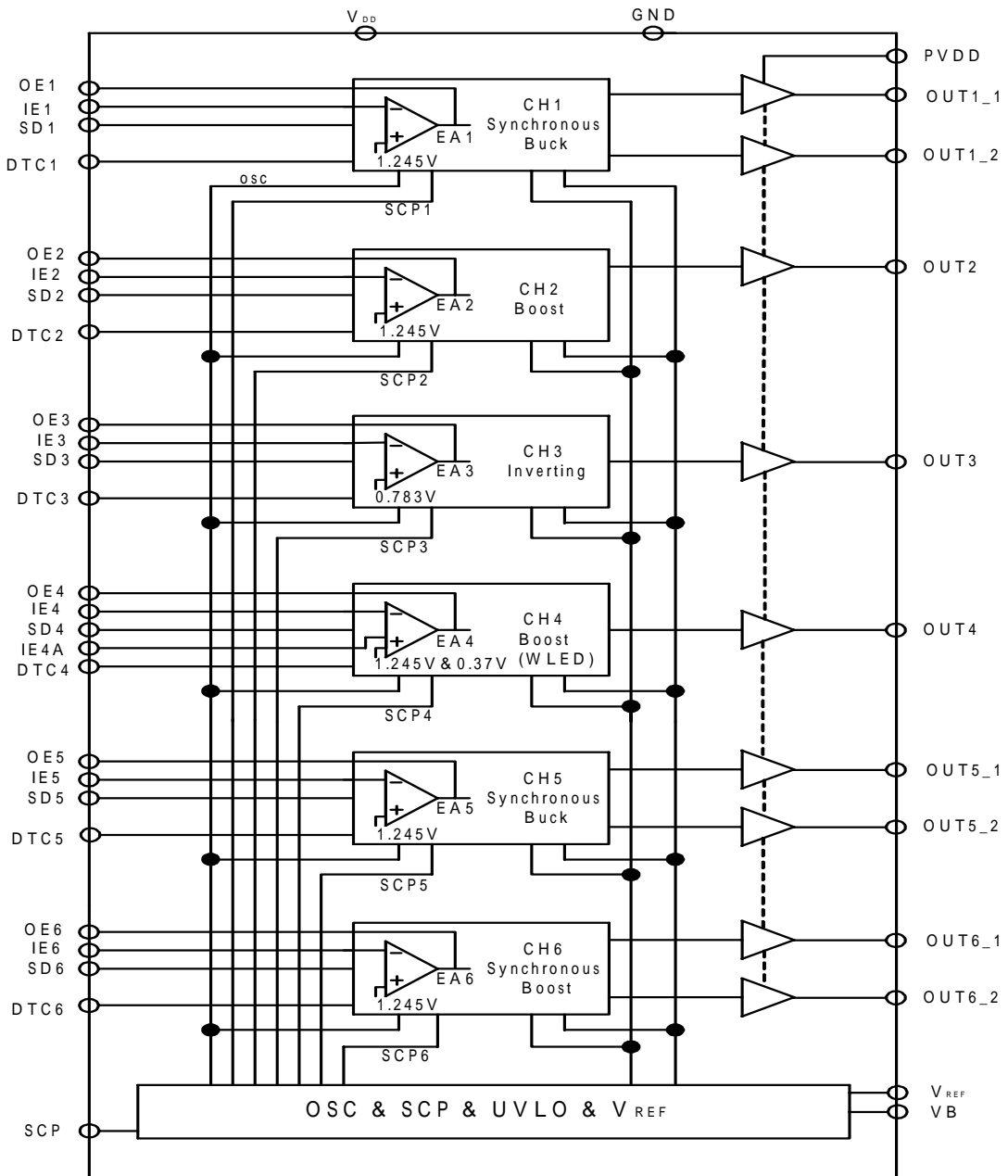


PIN DESCRIPTION (LQFP-48)

Pin No	Name	I/O	Function
1	NC	-	
2	SD1	I	ON/OFF Control for Channel 1 (CH1)
3	SD5	I	ON/OFF Control for Channel 5 (CH5)
4	SD6	I	ON/OFF Control for Channel 6 (CH6)
5	IE1	I	Inverted Input for Error Amplifier 1 (EA1)
6	IE5	I	Inverted Input for Error Amplifier 5 (EA5)
7	IE6	I	Inverted Input for Error Amplifier 6 (EA6)
8	DTC1	I	Dead Time Control of Channel 1 (CH1)
9	OE1	O	Output for Error Amplifier 1 (EA1)
10	DTC5	I	Dead Time Control of Channel 5 (CH5)
11	OE5	O	Output for Error Amplifier 5 (EA5)
12	NC	-	
13	NC	-	
14	DTC6	I	Dead Time Control of Channel 6 (CH6)
15	OE6	O	Output for Error Amplifier 6 (EA6)
16	VB	O	Reference Voltage 2.77V Output
17	GND	P	Ground
18	V _{DD}	P	Power Supply
19	V _{REF}	O	Reference Voltage 1.26V Output
20	SCP	-	Short Circuit Protect Capacitor Connection Pin
21	SD4	I	ON/OFF Control for Channel 4 (CH4)
22	SD3	I	ON/OFF Control for Channel 3 (CH3)
23	SD2	I	ON/OFF Control for Channel 2 (CH2)
24	NC	-	
25	NC	-	
26	IE4A	I	Inverted Input 2 for Error Amplifier 4 (EA4)
27	IE4	I	Inverted Input for Error Amplifier 4 (EA4)
28	IE3	I	Inverted Input for Error Amplifier 3 (EA3)
29	IE2	I	Inverted Input for Error Amplifier 2 (EA2)
30	OE4	O	Output for Error Amplifier 4 (EA4)
31	OE3	O	Output for Error Amplifier 3 (EA3)
32	OE2	O	Output for Error Amplifier 2 (EA2)
33	DTC4	I	Dead Time Control of Channel 4 (CH4)
34	DTC3	I	Dead Time Control of Channel 3 (CH3)
35	DTC2	I	Dead Time Control of Channel 2 (CH2)
36	NC	-	
37	NC	-	
38	OUT2	O	CH2 Totem Pole Type Output
39	OUT3	O	CH3 Totem Pole Type Output
40	OUT4	O	CH4 Totem Pole Type Output
41	OUT6_2	O	CH6 Synchronous Rectifier Side Output
42	PVDD	P	Output Buffer Power Supply
43	OUT6_1	O	CH6 Totem Pole Type Output
44	OUT5_1	O	CH5 Totem Pole Type Output
45	OUT5_2	O	CH5 Synchronous Rectifier Side Output
46	OUT1_1	O	CH1 Totem Pole Type Output
47	OUT1_2	O	CH1 Synchronous Rectifier Side Output
48	NC	-	



BLOCK DAIGRAM



**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Value	Unit
Supply Voltage	V_{DD}	7	V
Input Voltage (IE ₋ , DTC ₋ , SD ₋)	V_I	V_{DD}	V
Output Voltage	V_O	$V_{DD}+0.3$	V
Output Current	I_O	+20	mA
Output Peak Current (t _w 2μs, Duty 5%)	I_{opeak}	+200	mA
Operating Temperature Range	T_C	- 20 to + 85	
Storage Temperature Range	$T_{storage}$	- 45 to + 125	

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Max	Unit
Startup Supply Voltage, CH6	V_{DD}	1.4	6.5	V
Operating Voltage, V_{DD} (CH1~CH6)	V_{DD}	3.0	6.5	V
Input Voltage, IE ₋ , (IE1~IE6)	V_I	0.28	1.55	V
Output Voltage	V_O	0	V_{DD}	V
Output Current, (CH1~CH6)	I_O	-	15	mA
Output Current of Error Amplifier	I_{OE}	-	- 60	μA
Operating Free-Air Temperature	T_C	- 20	+ 85	



ELECTRICAL CHARACTERISTICS, $V_{DD} = 5.0V$ (UNLESS OTHERWISE SPECIFIED) (SEE NOTE 1)

UNDER VOLTAGE PROTECTION

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Upper Threshold Voltage	V_{UPH}	$T_C = 25$	2.53	2.72	2.91	V
Lower Threshold Voltage	V_{UPL}	$T_C = 25$	-	2.47	-	V
Hysteresis ($V_{UPH} - V_{UPL}$)	V_{HYS}	$T_C = 25$	-	0.25	-	V

SHORT CIRCUIT PROTECTION CONTROL

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Threshold Voltage	V_t	CH1, 2, 4,5,6,	1.220	1.245	1.285	V
		CH3	0.28	0.33	0.38	
Latch Reset Voltage	V_R	$T_C = 25$	-	-	1.4	V
Short-Circuit Detect Threshold Voltage	V_{tscd}		0.58	0.63	0.68	V
SCP Terminal Source Current	I_{SCP}		-3.5	-2.5	-1.5	μA

REFERENCE VOLTAGE

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Voltage	V_{REF}	$I_{REF} = -1mA, T_C = 25$	1.227	1.245	1.263	V
Short-Circuit Output Current	I_{os}	$V_{REF} = 0$	-35	-17	-8	mA
Input Voltage Regulation	V_{RI}	$I_{REF} = -1mA, V_{DD} = 3.0V \text{ to } 6.5V$	-10	-	10	mV
Output Regulation	V_{RO}	$I_{REF} = -0.1mA \text{ to } -1mA$	-10	-	10	mV
Reference Voltage Change with Temperature	$\Delta V_{REF} / V_{REF}$	$T_C = -20 \text{ to } +85$	-	0.5	-	%

Note 1: Typical values of all parameters except for $\Delta V_{REF} / V_{REF}$ is specified at $T_C = 25$.



ELECTRICAL CHARACTERISTICS, $V_{DD} = 5.0V$ (UNLESS OTHERWISE SPECIFIED) (SEE NOTE 1) (CONT.)

EA (ERROR AMPLIFIER)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Threshold Voltage	V_{TH}	CH1,2,5,6	1.227	1.245	1.263	V
	V_{TH3}	CH3	0.768	0.783	0.798	
	V_{TH4}	CH4	1.227	1.245	1.263	
	V_{TH4A}	CH4	0.352	0.370	0.388	
Input Bias Current	I_{IB}	CH1~6 $V_I = 0.28V$ to $1.55V$	-	± 10	± 20	nA
Input Voltage Range	V_{IR}	CH1~6	0.28	-	1.55	V
Open-Loop Voltage Gain	A_{VO}		65	83	-	dB
Unity-Gain Bandwidth	BW_1		-	10	-	MHz
Output Voltage Swing	V_{OS+}		1.3	-	-	V
	V_{OS-}		-	-	0.2	
Output Sink Current	I_{OS+}	OE=0.7V	2.5	5.0	-	mA
Output Source Current	I_{OS-}	OE=0.7V	-	-106	-60	μA

DEAD-TIME CONTROL

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Bias Current	I_{BDTC}	$V_{DTC} = 0.2V$ to $1.3V$	-	-	200	nA
Input Threshold Voltage (DTC1,2,4,5)	V_{d0}	Duty = 0%, $f_{OSC} = 500kHz$	0.323	0.423	-	V
	V_{d100}	Duty = 100%, $f_{OSC} = 500kHz$	-	1.125	1.225	
Input Threshold Voltage (DTC6)	V_{6d0}	Duty = 0%, $f_{OSC} = 500kHz$	0.223	0.323	-	V
	V_{6d100}	Duty = 100%, $f_{OSC} = 500kHz$	-	1.025	1.125	
Input Threshold Voltage(DTC3)	V_{3d0}	Duty=0%, $f_{OSC}=500kHz$	-	1.125	1.225	V
	V_{3d100}	Duty=100%, $f_{OSC}=500kHz$	0.323	0.423	-	

**ELECTRICAL CHARACTERISTICS, $V_{DD} = 5.0V$ (UNLESS OTHERWISE SPECIFIED) (SEE NOTE 1) (CONT.)****OUTPUT STAGE**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output ON Resistor	R_{OH}	$I_o = -15mA$ (CH1~CH5)	-	18	30	Ω
		$I_o = -15mA$ (CH6)	-	9	15	
	R_{OL}	$I_o = 15mA$ (CH1~CH5)	-	16	25	Ω
		$I_o = 15mA$ (CH6)	-	9	15	

SHUTDOWN (SD-)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
High Level SD-	H_{SD}	Active Mode	1.4	-	-	V
Low Level SD-	L_{SD}	Stand-by Mode	-	-	0.6	V
Input Current		CH1~CH6	-	± 10	± 20	nA

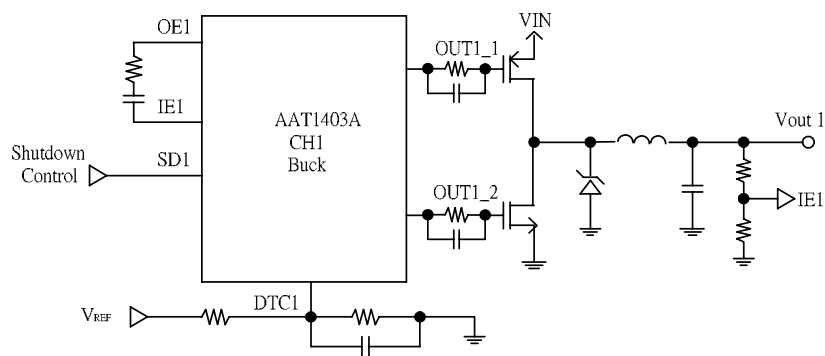
OPERATING CURRENT

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current	I_{DD-OFF}	SD1~SD6= 0V	-	-	10	μA
	I_{DD-ON}	SD1~SD6= "Hi"	-	4.8	7.0	mA

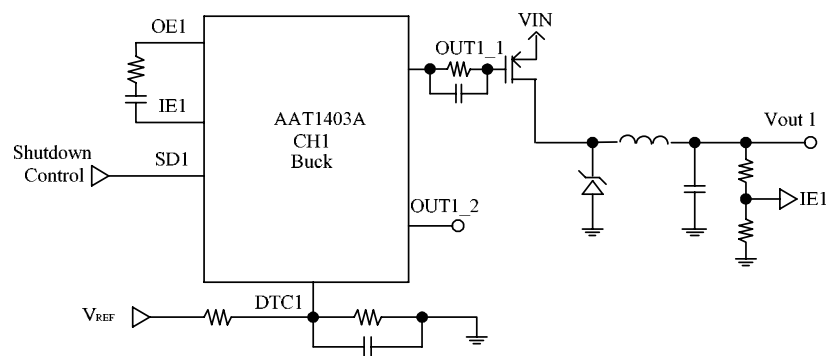


APPLICATION CIRCUIT

CH1 Synchronous Solution



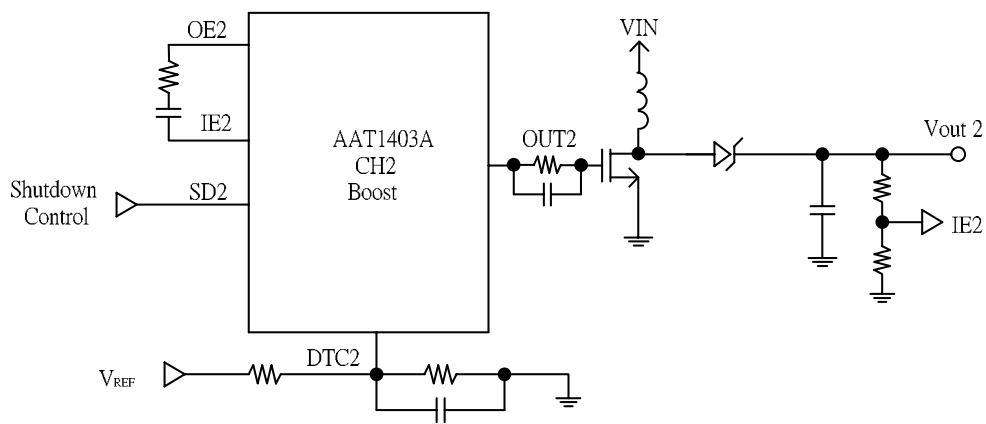
CH1 Non-Synchronous Solution



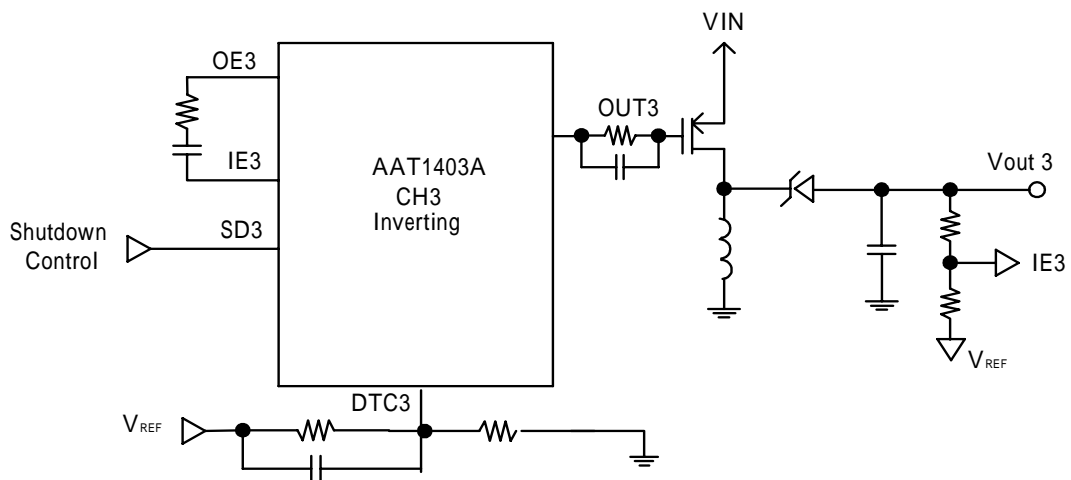


APPLICATION CIRCUIT

CH2 Solution



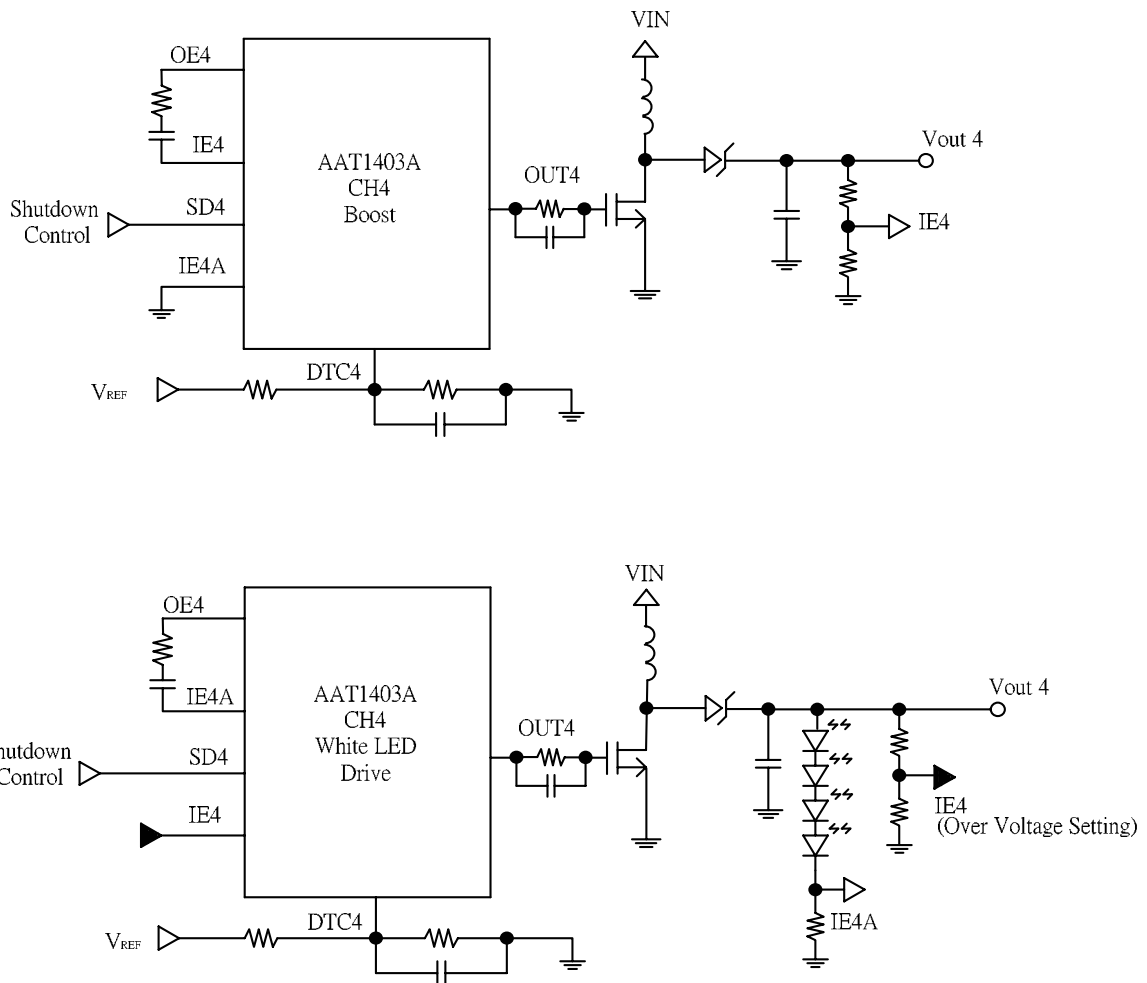
CH3 Solution





APPLICATION CIRCUIT

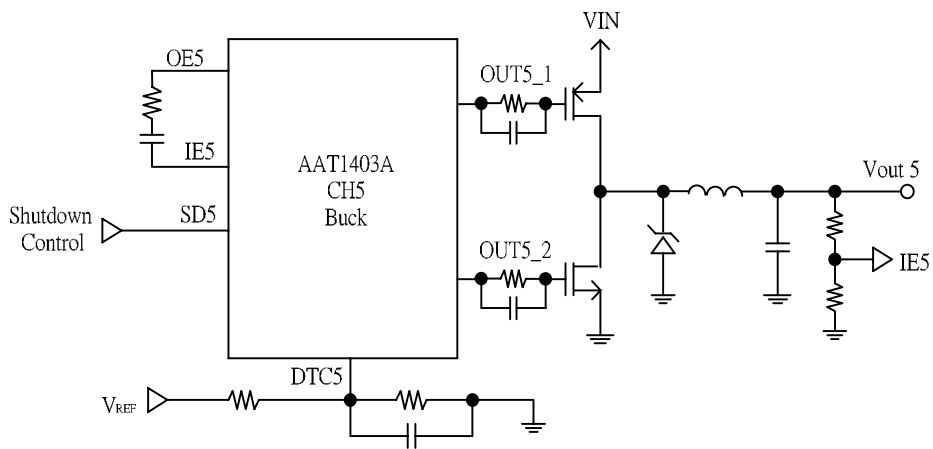
CH4 Solution



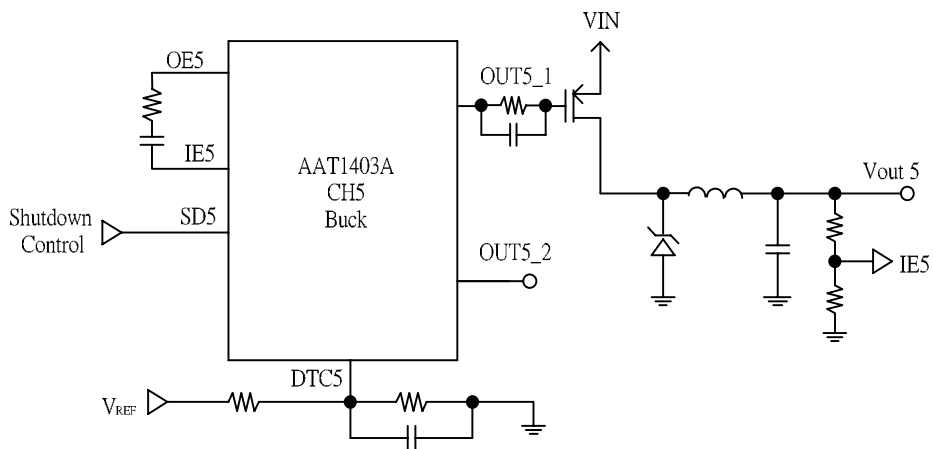


APPLICATION CIRCUIT

CH5 Synchronous Solution



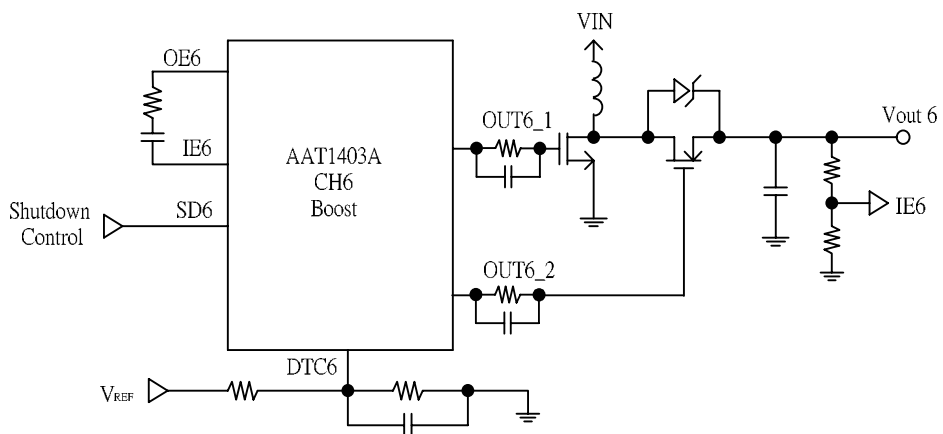
CH5 Non-Synchronous Solution



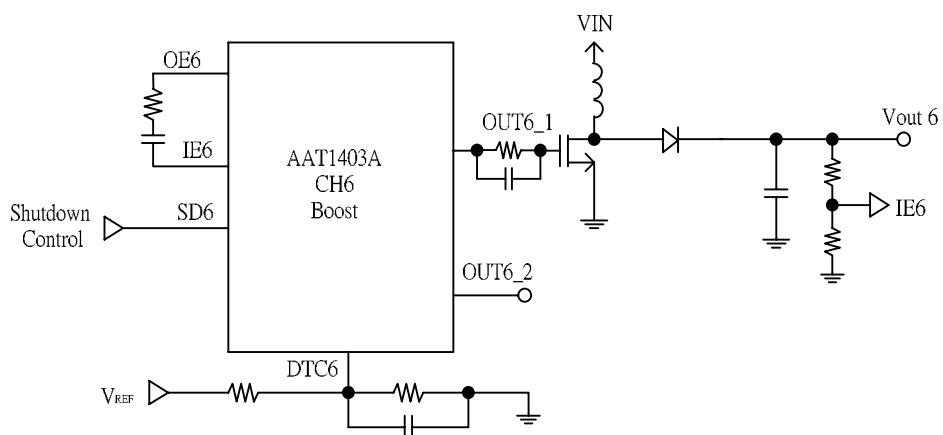


APPLICATION CIRCUIT

CH6 Synchronous Solution

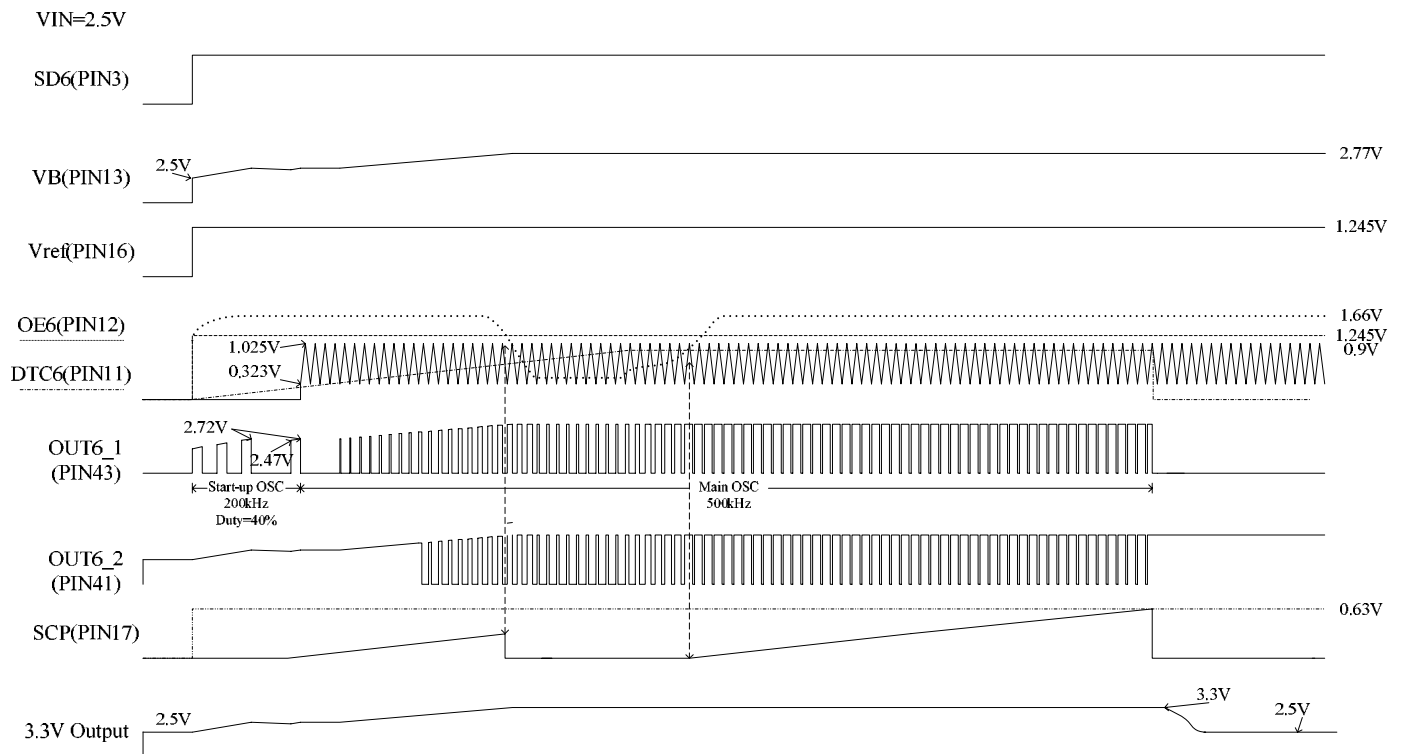


CH6 Non-Synchronous Solution



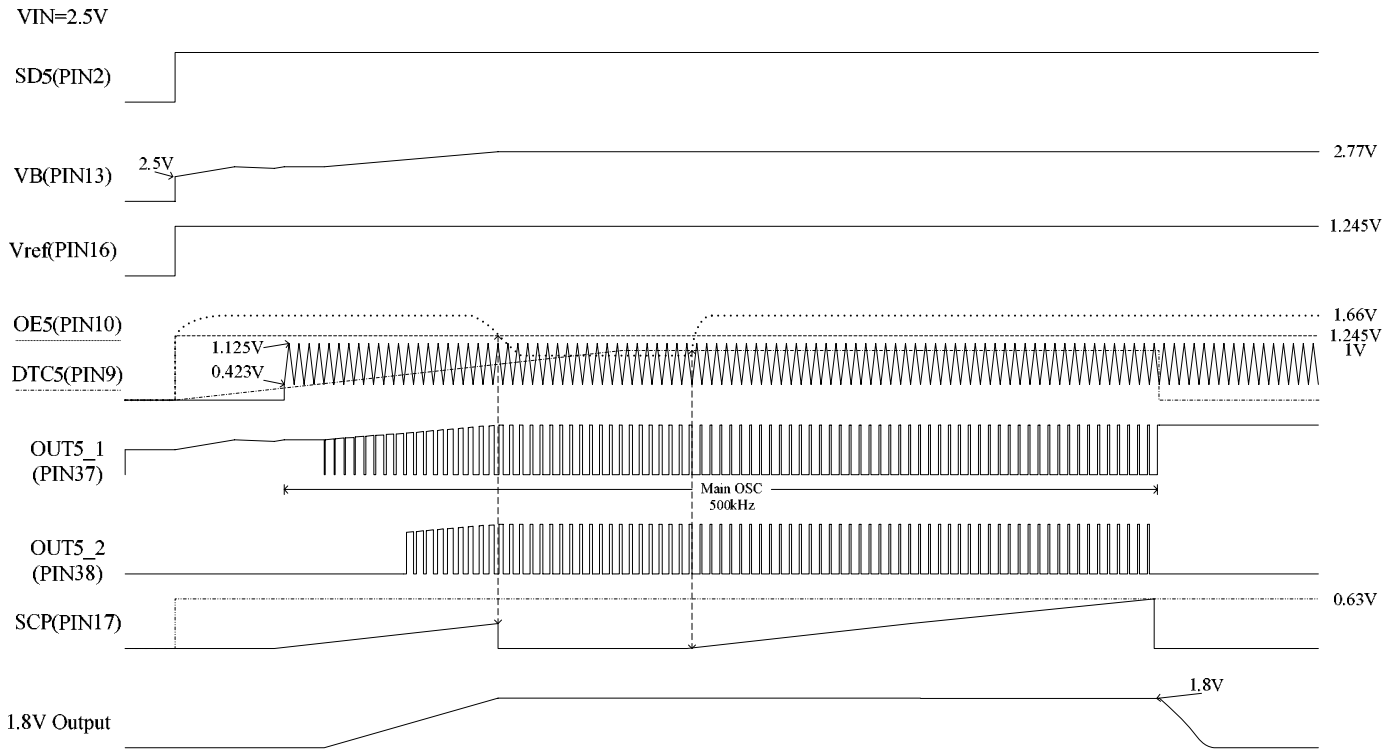


CH6 Timing Chart



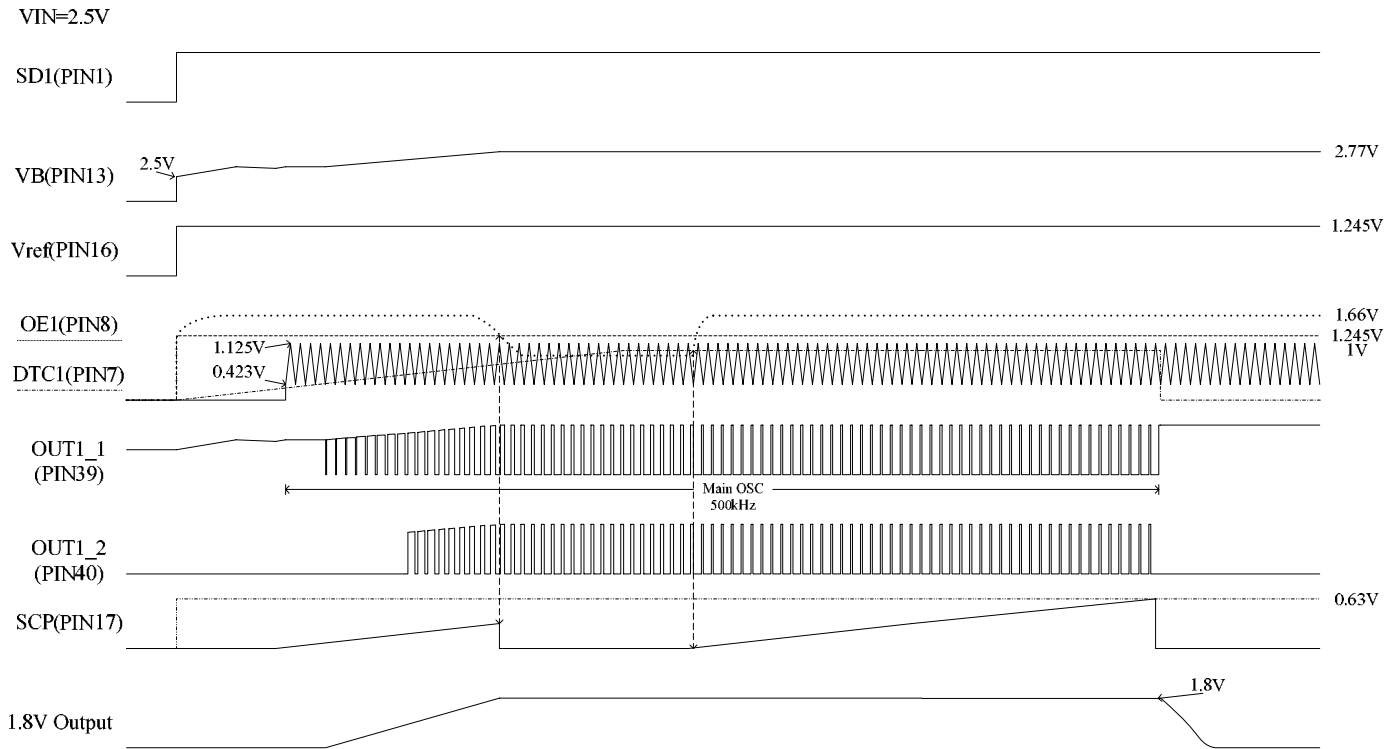


CH5 Timing Chart



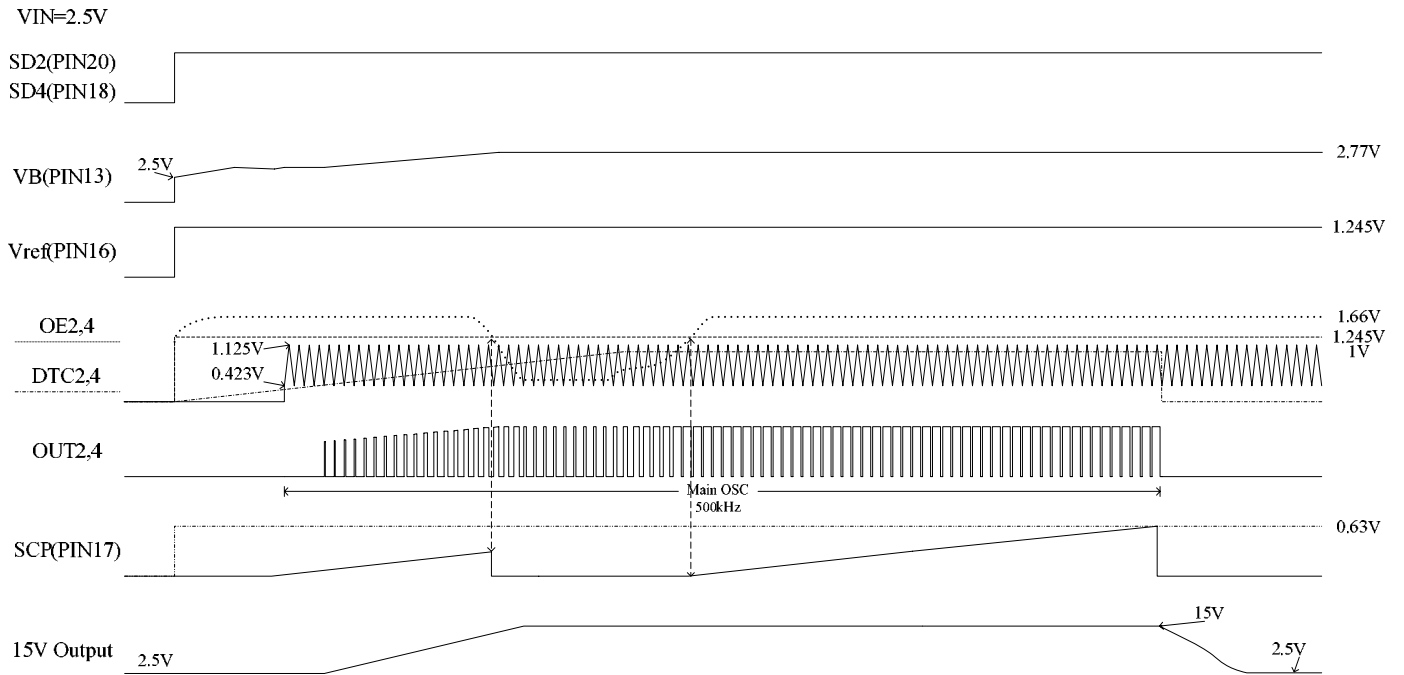


CH1 Timing Chart



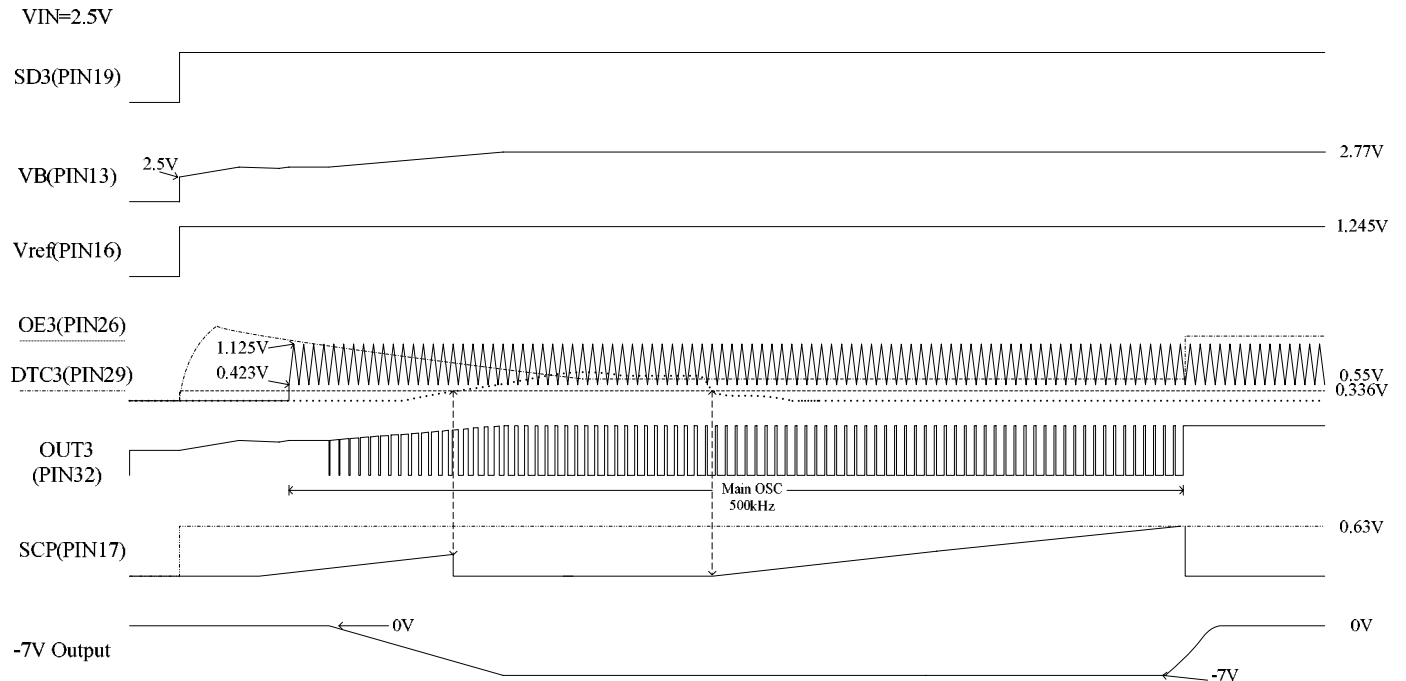


CH2,4 Timing Chart



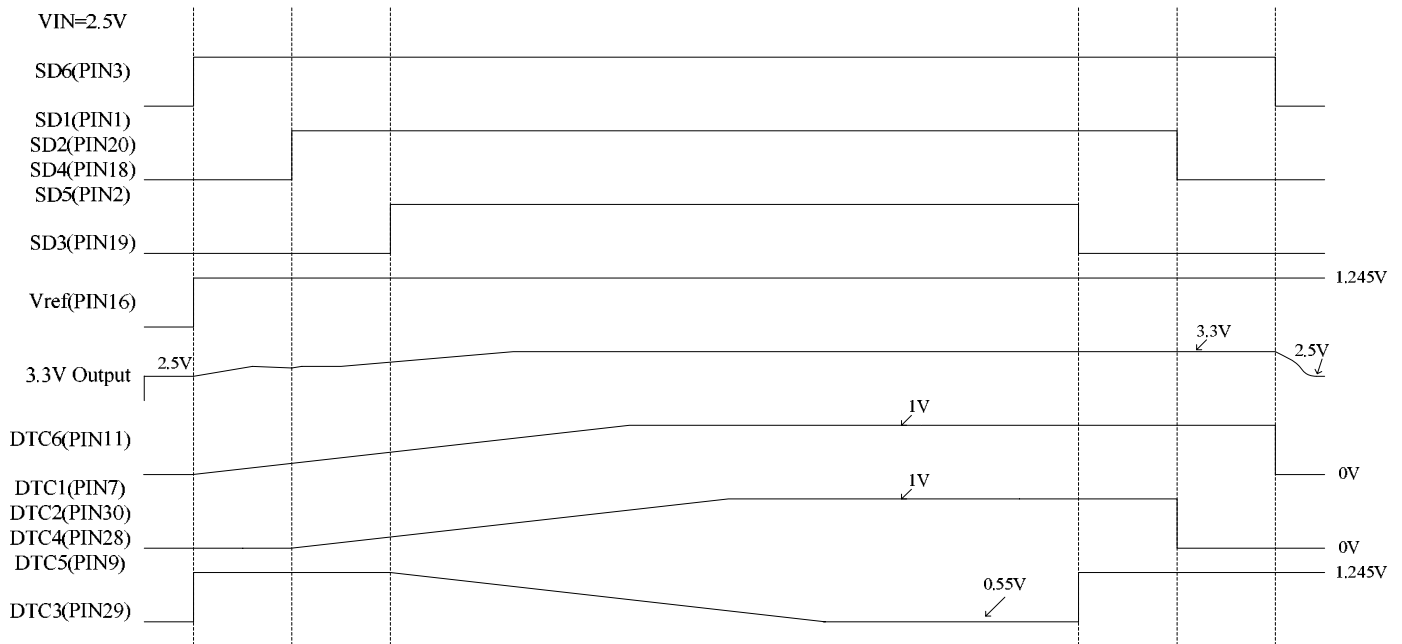


CH3 Timing Chart



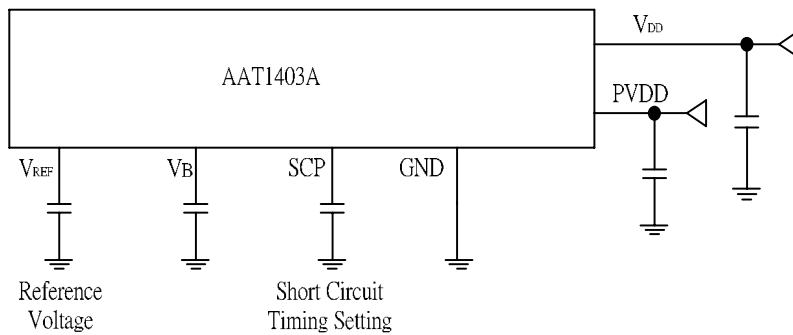


Soft-Start and Shutdown Operation





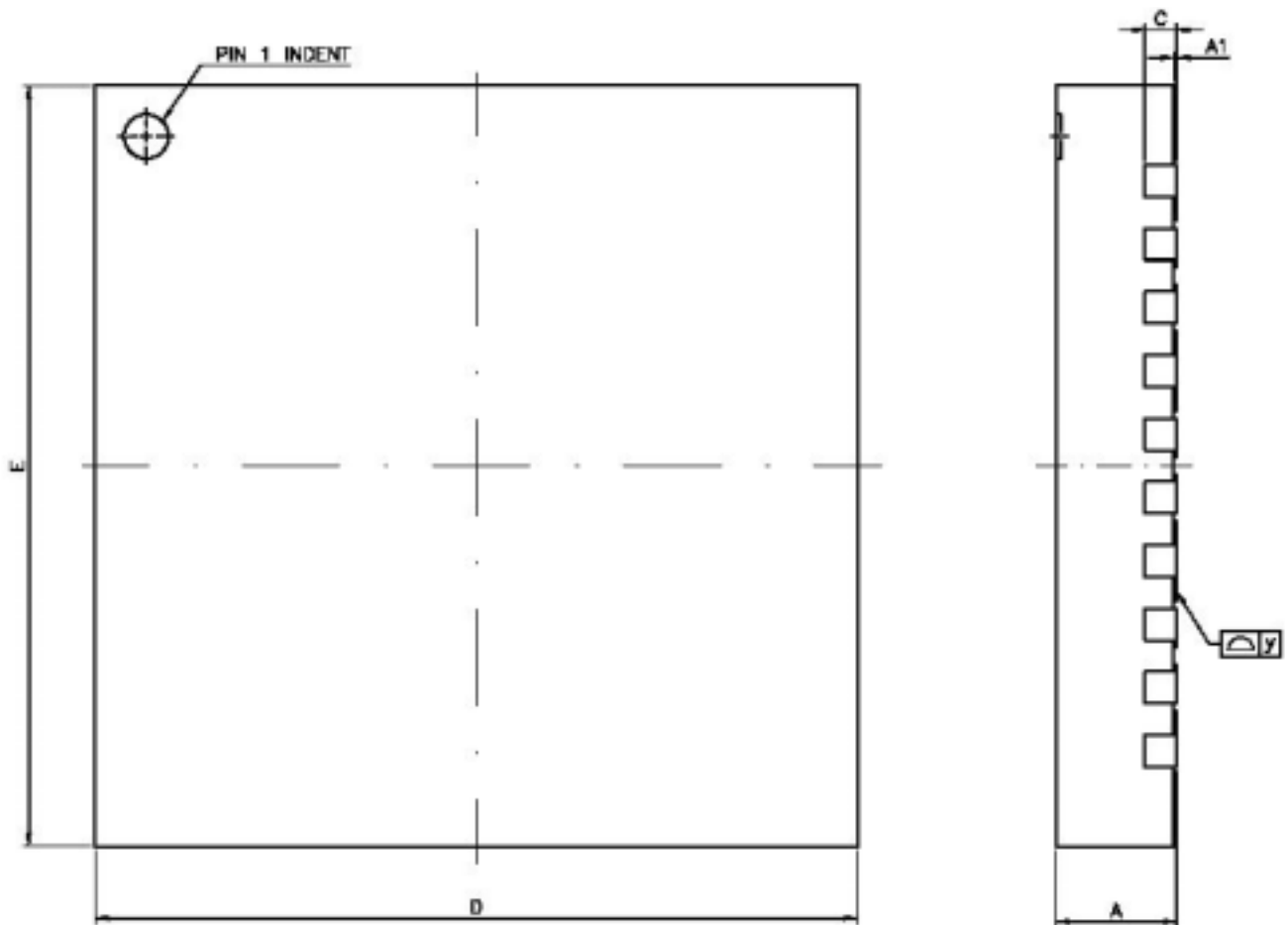
OPERATION CONDITION SETTING





PACKAGE DIMENSION

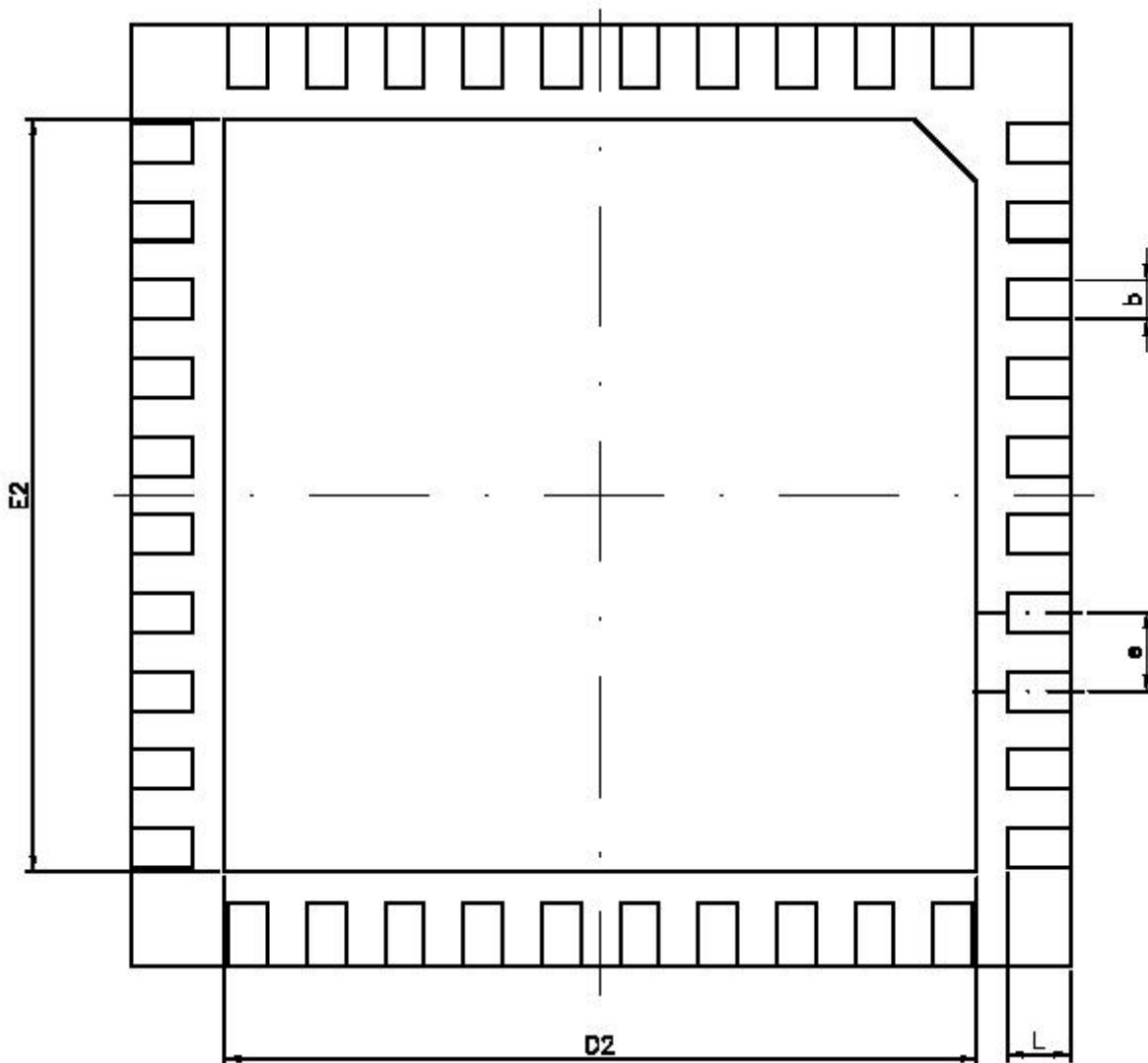
VQFN40 PACKAGE





PACKAGE DIMENSION

VQFN40 PACKAGE (CONT.)





PACKAGE DIMENSION (CONT.)

VQFN40 PACKAGE (CONT.)

SYMBOL	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	0.80	0.90	1.00	0.031	0.035	0.039
A1	0.00	0.02	0.05	0	0.0008	0.0020
b	0.225	0.250	0.275	0.009	0.010	0.011
C	0.19	0.20	0.25	0.0075	0.0080	0.0100
D	5.90	6.00	6.10	0.232	0.236	0.240
D2	4.650	4.800	4.950	0.183	0.189	0.195
E	5.90	6.00	6.10	0.232	0.236	0.240
E2	4.650	4.800	4.950	0.183	0.189	0.195
e	-----	0.50	-----	-----	0.020	-----
L	0.35	0.40	0.45	0.014	0.016	0.018
y	0	-----	0.076	0	-----	0.003

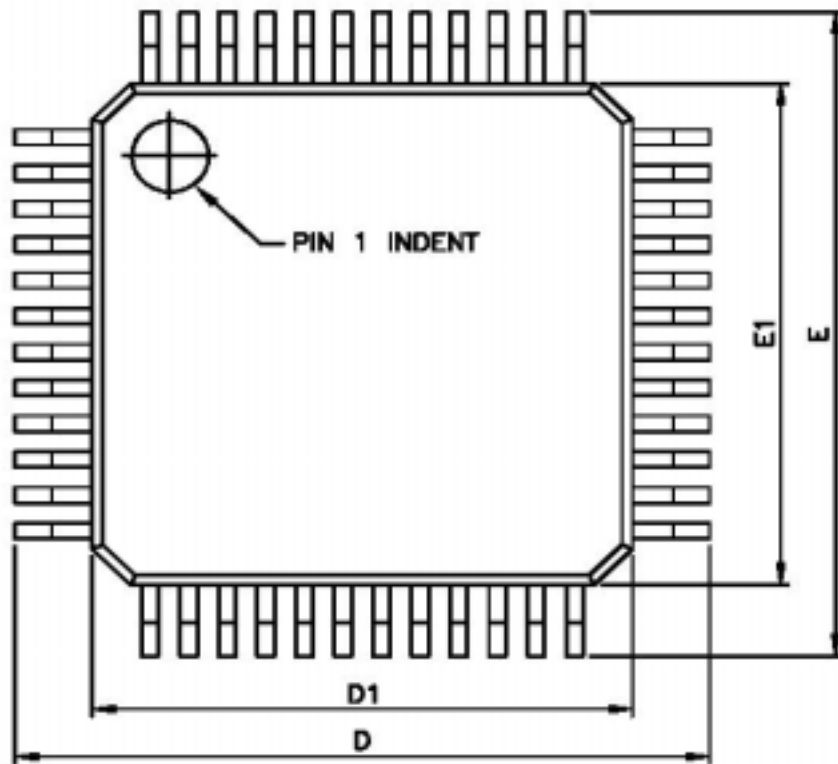
NOTE: THE TERMINAL #1 IDENTIFIER IS A LASER MARKED FEATURE.



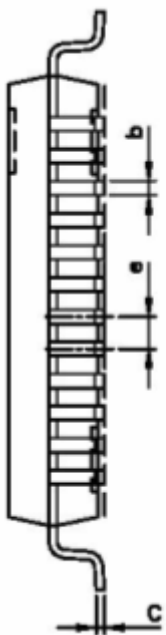
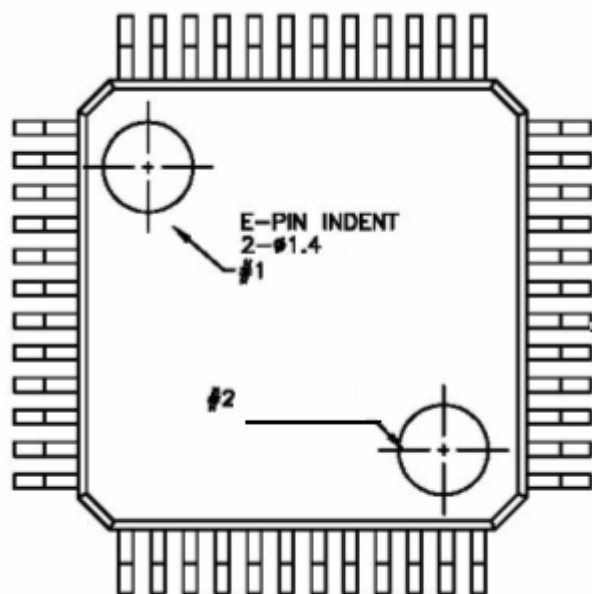
PACKAGE DIMENSION

LQFP48 PACKAGE

TOP VIEW

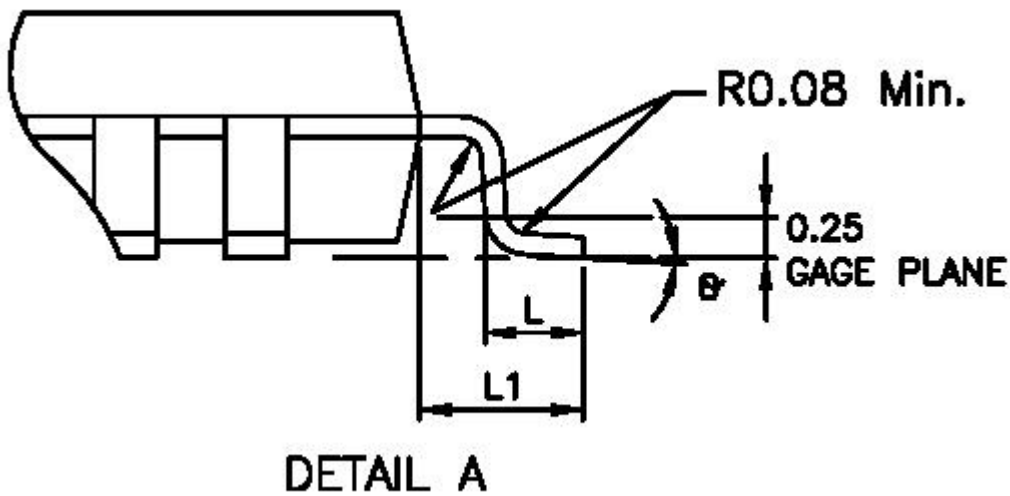
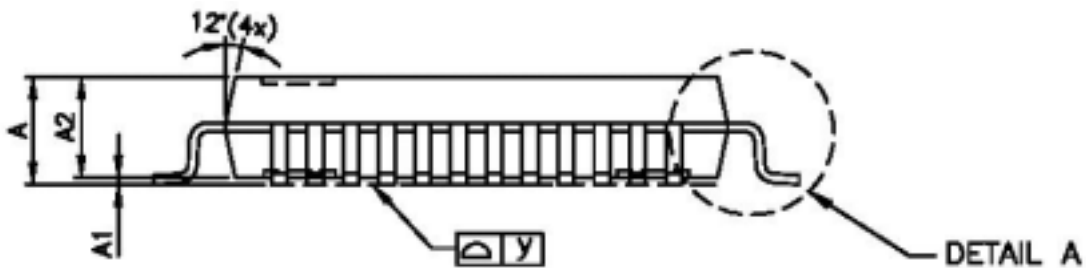


BOTTOM VIEW





PACKAGE DIMENSION
LQFP48 PACKAGE (CONT.)





PACKAGE DIMENSION
LQFP48 PACKAGE (CONT.)

SYMBOL	DIMENSION IN MILLIMETERS		
	MIN	TYP	MAX
A	-----	-----	1.60
A1	0.05	-----	0.15
A2	1.35	1.40	1.45
b	0.17	0.22	0.27
C	0.09	-----	0.20
E	8.80	9.00	9.20
E1	6.90	7.00	7.10
D	8.80	9.00	9.20
D1	6.90	7.00	7.10
e	-----	0.50	-----
L	0.45	0.60	0.75
L1	-----	1.00	-----
θ	0° C	3.5° C	7.0° C
y	0	-----	0.08