

KA7543

Advanced Feedback Dimming Ballast Control IC

Features

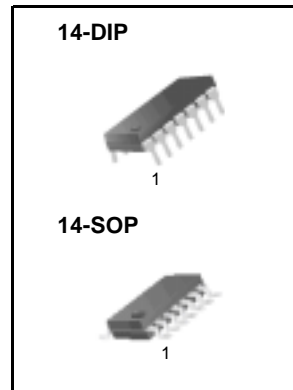
- Lamp Current Feedback
- Soft Start on Feedback
- Voltage Dimming (0V~2V) on Feedback
- Switch Off Control ($V_{dm}=5V$)
- Soft Dimming Control
- No Lamp Protection
- One Lamp Detection for Feedback
- Abnormal Protection
- Low Start-up and Operating Supply Current
- UVLO with 1.8V Hysteresis
- Totem Pole Output
- Trimmed 1.5% Internal Bandgap Reference
- 14-DIP & 14-SOP

Applications

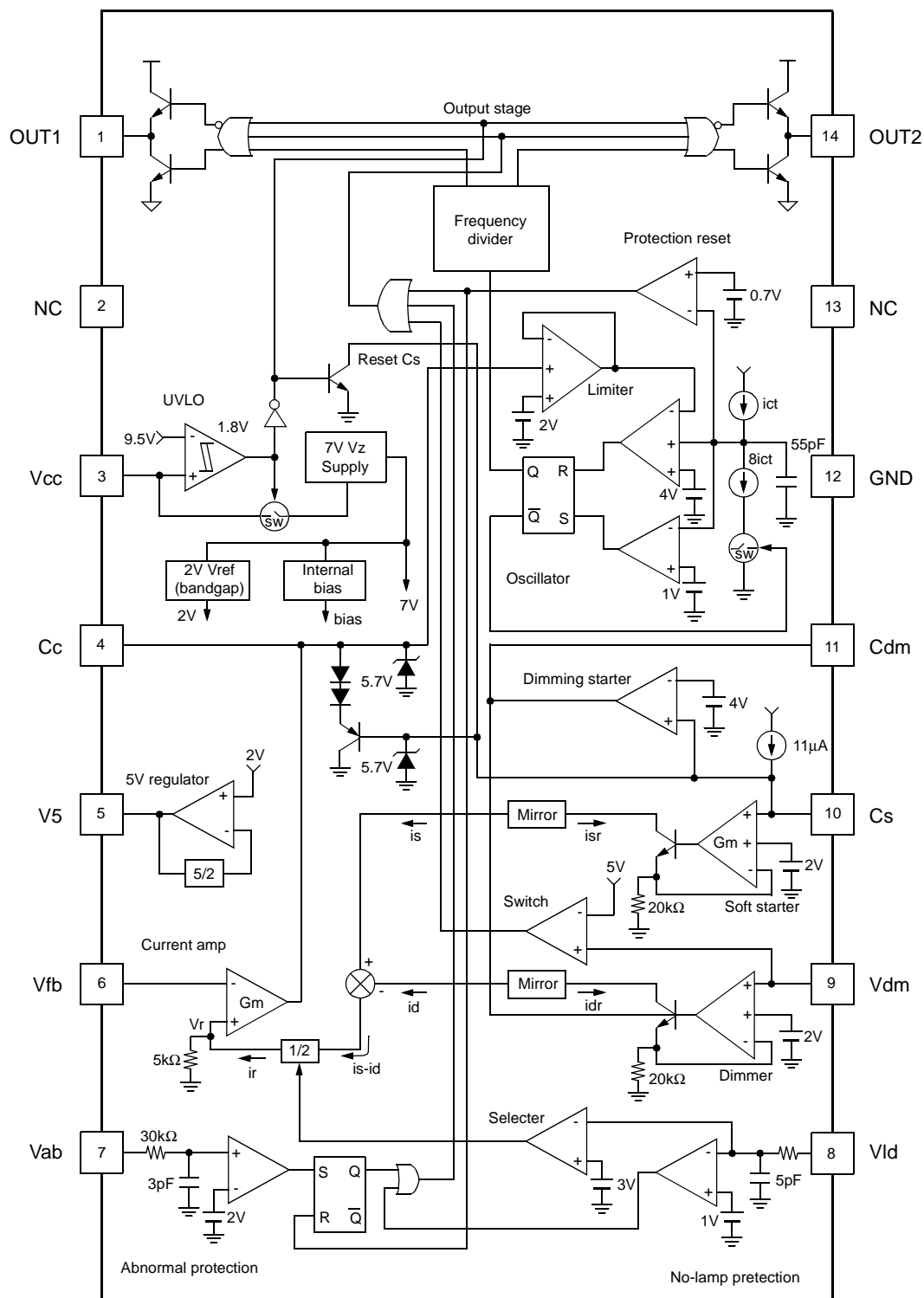
- Electronic Ballast
- Lighting Control System
- Half Bridge Drive Control System

Descriptions

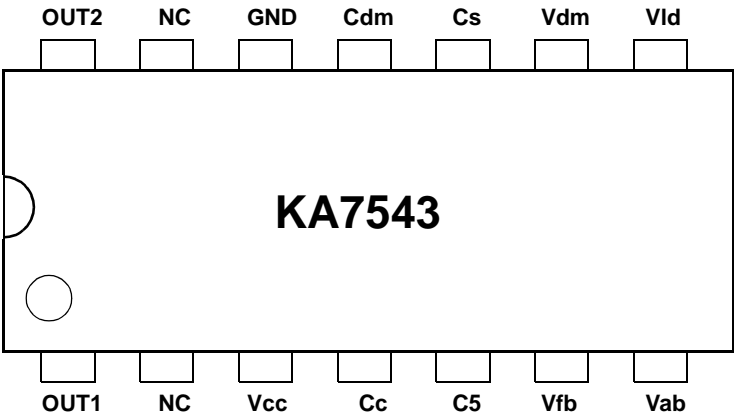
The KA7543 is an advanced lamp current feedback dimming control IC. This ballast control IC provides all of the necessary features to implement wide range dimming control, soft start and constant power consumption for intelligent electronic ballast systems. The KA7543 is optimized for advanced electronic ballast systems requiring minimum board area. External component counts can be reduced by adopting the KA7543. Current feedback control method of the inverter status is one of the most attractive merits in KA7543. Internal soft start circuitry eliminates the need for external soft start discrete components. Voltage controlled soft dimming circuit is built into the IC to control the lighting output in a wide range. Protection circuitry, no lamp protection, abnormal protection, one lamp detection, UVLO, restart on lamp adding, have been added.



Internal Block Diagram



Pin Assignments



Pin Definitions

Pin Number	Pin Name	Pin Function Description
1	OUT1	Drive Output 1
2	NC	No Connection
3	Vcc	Supply Voltage Input
4	Cc	Compensation Input
5	V5	5V Voltage Source
6	Vfb	Negative Feedback Input
7	Vab	Abnormal Protection Input
8	Vld	Lamp Detection Input
9	Vdm	Dimming Control Input
10	Cs	Soft Start Time Control Input
11	Cdm	Soft Dimming Control Input
12	GND	Ground
13	NC	No Connection
14	OUT2	Drive Output 2

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply Voltage	V _{CC}	30	V
Peak Drive Output Current	I _{OH} , I _{OL}	±300	mA
Drive Output Clamping Diodes V _O > V _{CC} , or V _O < -0.3	I _{clamp}	±10	mA
Operating Temperature Range	T _{opr}	-25 to 85	°C
Storage Temperature Range	T _{stg}	-65 to 150	°C
Power Dissipation	P _d	0.8	W
Thermal Resistance (Junction-to-air)	θ _{ja}	100	°C / W

Absolute Maximum Ratings (-25°C ≤ T_a ≤ 85°C)

Parameter	Symbol	Value	Unit
Temperature Stability For Reference Voltage (V _{ref})	ΔV _{ref} (Typ)	15	mV
Temperature Stability For Operating Frequency (f _s)	Δf _s (Typ)	8	kHz

Electrical Characteristics

Unless otherwise specified, V_{CC}=12V, T_a=25°C.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
UNDER VOLTAGE LOCK OUT SECTION						
Start Threshold Voltage	V _{TH(st)}	V _{CC} increasing	8.7	9.5	10.3	V
UVLO Hysteresis	HY(st)	-	1.5	1.8	2.1	V
5V Reference Voltage(Note1)	V ₅	I ₅ = 0mA	4.9	5	5.1	V
SUPPLY CURRENT SECTION						
Start Up Supply Current	I _{ST}	V _{CC} =8.5V	-	0.2	0.27	mA
Operating Supply Current	I _{CC}	Output not switching	-	7	9	mA
Dynamic Operating Supply Current (Note1)	I _{DCC}	f _o = 50kHz, C _I =1nF	-	8	12	mA
CURRENT AMPLIFIER SECTION(Note 1)						
Output Sink Current	I _{ea(i)}	V _{fb} = 2V	12	15	18	μA
Output Source Current	I _{ea(o)}	V _{fb} = 0V	12	15	18	μA

Electrical Characteristics (Continue)

Unless otherwise specified, V_{CC}=12V, T_a=25°C.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
1 Lamp Feedback Voltage	V _{fb1}	V _{ld} =2V	0.425	0.5	0.575	V
2 Lamp Feedback Voltage	V _{fb2}	V _{ld} =4V	0.85	1	1.15	V
Output Voltage High	V _{ea(h)}	V _{fb} = 0V	5.5	5.7	5.9	V
Output Voltage Low	V _{ea(l)}	V _{fb} = 2V	-	-	0.4	V
OSCILLATOR SECTION(Note 1)						
Reference Frequency	f _{ref}	V _C =3.0V	37	45	53	kHz
Reference Dead Time	t _d	V _C =3.0V	1.2	1.4	1.6	μs
Soft Start Frequency	f _{ss}	V _C =0V	77	-	-	kHz
Soft Start Time Current	I _{ss}	V _C =0V	9.2	11	12.8	μA
VOLTAGE INPUT DIMMING SECTION(Note 1)						
Dimming Voltage Range	ΔV _{dm}	-	0	-	2	V
Dimming Start Voltage	V _{dm}	V _{dm} =0V	3.85	4	4.15	V
Initial Dimming Output Voltage	V _{dm}	V _{dm} =0V	-0.1	0	0.1	V
OUTPUT 1/2 SECTION						
Rising Time (Note2)	t _r	V _{CC} =12V, C _I =1nF	-	200	280	ns
Falling Time(Note2)	t _f	V _{CC} =12V, C _I =1nF	-	50	90	ns
Output Voltage with UVLO activated	V _{omin(o)}	V _{CC} =5V, I _O =100μA	-	-	0.9	V
PROTECTION SECTION						
Lamp Detection Voltage	V _{ld}	-	2.5	3	3.5	V
Abnormal Detection Voltage	V _{ab}	-	1.6	2	2.4	V
Switch Off Detection Voltage	V _{so}	-	4.7	5	5.3	V
No Lamp Detect Voltage	V _{nd}	-	0.85	1	1.15	V
PROTECTION RESET SECTION						
Protection Reset Voltage	V _{pr}	-	-	0.7	-	V

Notes :

1. This parameter should be tested in V_{CC} = 11V, 14V, 30V.
2. This parameter, although guaranteed, is not tested in production.

Operating Description

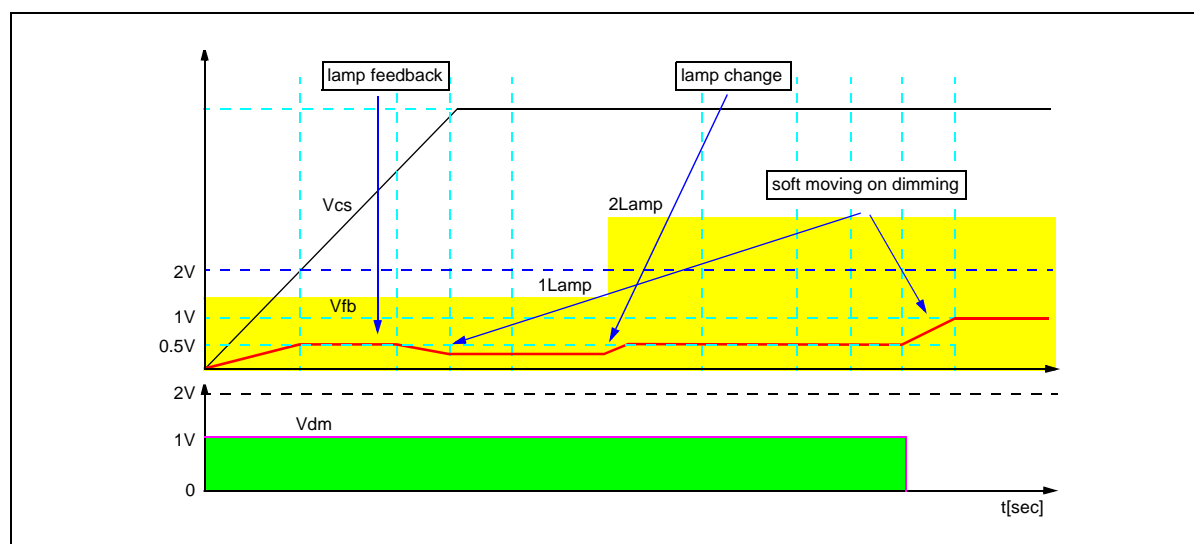


Figure 1. Operation Characteristics

The KA7543 is an advanced, lamp current feedback ballast dimming control IC which drives half bridge converter. This control IC provides all the necessary features to implement wide range dimming control, soft-start and constant power consumption for the intelligent electronic ballast system. The number of external components can be minimized by adopting the KA7543. Protection circuitry, no lamp protection, abnormal protection, one lamp detection, UVLO and restart on lamp adding have been included in the KA7543. Fig. 1 shows the operational characteristic of the KA7543 according to time and lamp count variation. When the V_{cc} voltage reaches the start-up threshold voltage(9.5V), the soft start capacitor begins to be charged. When the C_s pin voltage, V_{cs} is over 2V, the soft start operation ends. During the soft start operation, the reference voltage which controls the lamp current is proportional to V_{cs} . Dimming operation starts when V_{cs} becomes 4V and the change rate of dimming is determined by the capacitor connected to the C_{dm} pin. The more smooth dimming can be accomplished by the larger capacitor connected to the C_{dm} pin.

Uvlo(Under Voltage Lock Out)

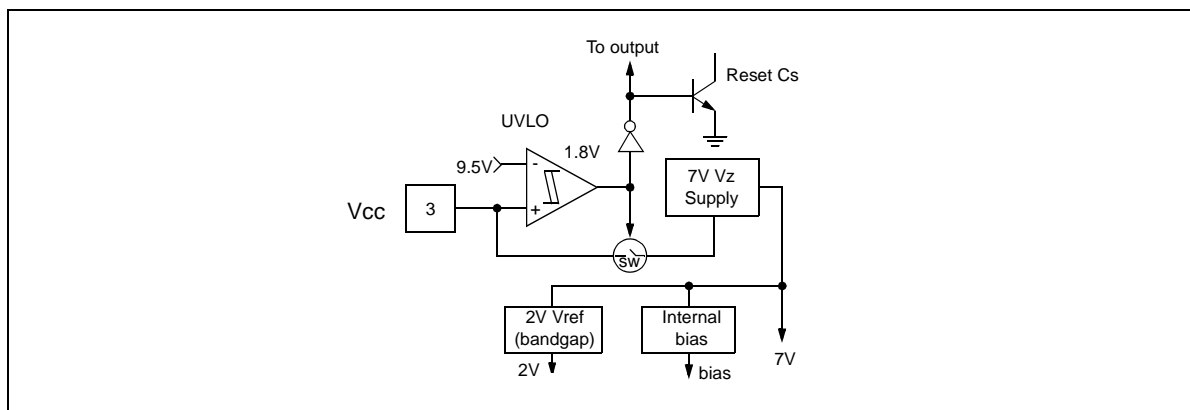


Figure 2. UVLO

Until the V_{cc} voltage reaches the start-up threshold voltage(9.5V), UVLO circuit lowers the IC operating current below $270\mu A$. When the V_{cc} voltage reaches the start-up threshold voltage, it generates IC reference voltage(V_{ref}) and supplies bias current for the whole circuitry. The hysteresis of UVLO circuit is 1.8V.

Soft Start

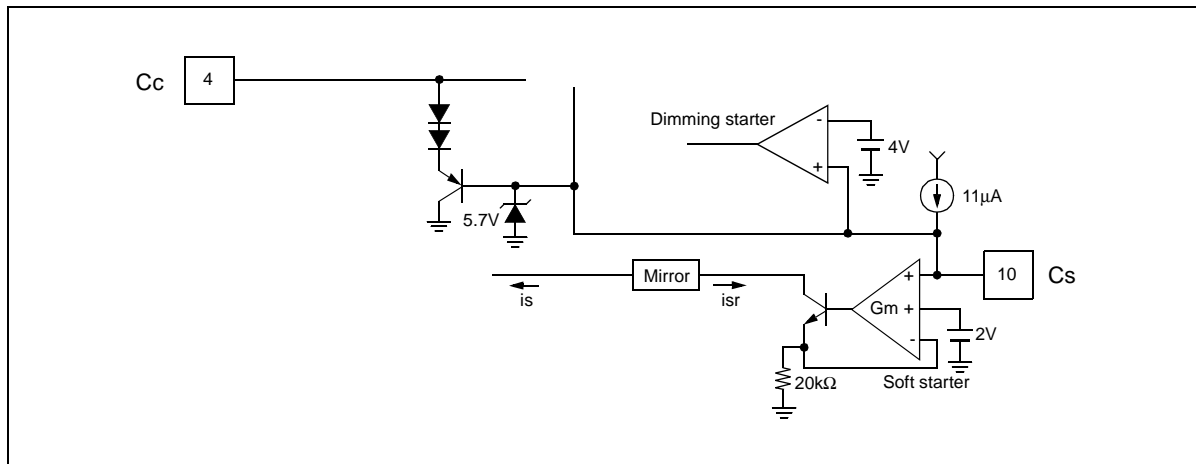


Figure 3. Soft Start

The soft start circuit charges the soft start capacitor, Cs connected to Cs pin. So the Cs pin voltage increases linearly when start-up and the current(i_s) makes the reference voltage(V_r) which is proportional to i_s current. The i_s current is maximum when the Cs pin voltage is 2V. The highest soft start frequency is determined by the Cc pin voltage($V_{be}+2V_d$). The operating frequency linearly decreases until the Cs pin voltage reaches 2V. During the soft start operation, the reference voltage which controls the lamp current is proportional to V_{cs} . If the Cs pin voltage is higher than 2V, the operating frequency is controlled by the feedback reference voltage. The UN-UVLO signal discharges capacitor Cs when the V_{cc} voltage is lower than UV.

Oscillator

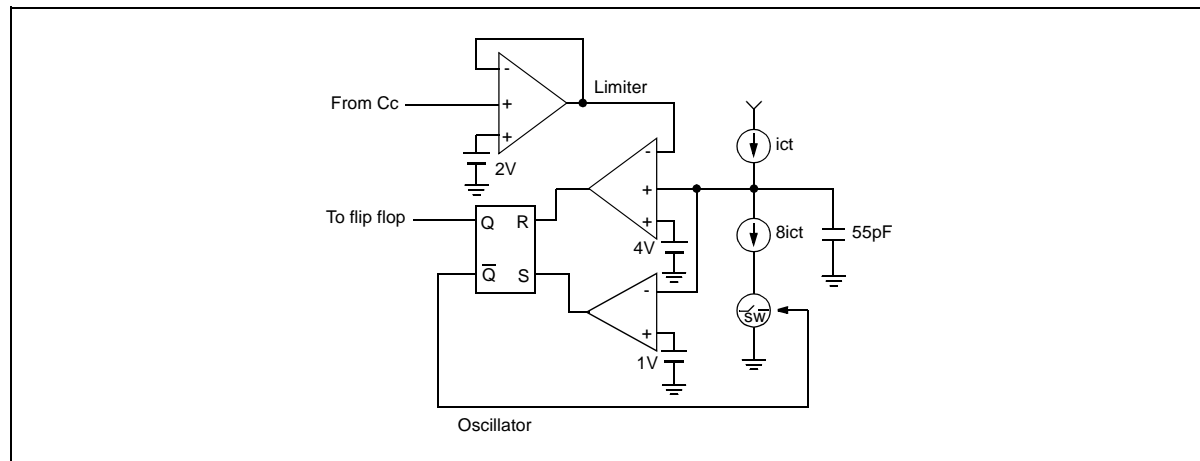


Figure 4. Oscillator

The oscillator block consists of two comparators and the ratio of charging time and discharging time is 7:1. The current source, i_{ct} charges 55pF capacitor until the capacitor voltage meets the upper limit voltage. After that time, $7 \cdot i_{ct}$ current discharges the capacitor until it meets the lower limit voltage, 1V. The upper limit voltage is between 2V and 4V. The operating frequency is highest when the upper limit voltage is 2V and it is lowest when the upper limit voltage is 4V. The lowest operating frequency guarantees the zero voltage switching operation of the ballast system.

Dimming Control Stage

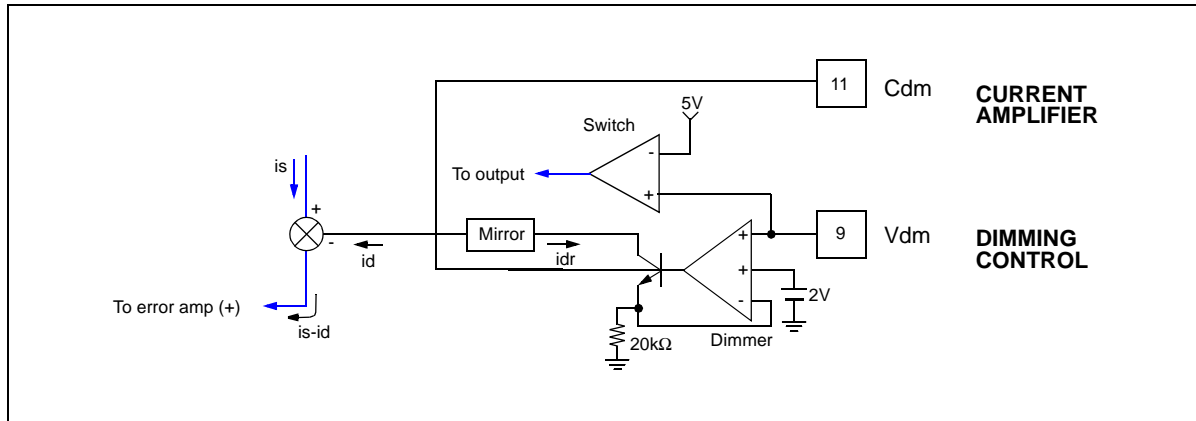


Figure 5. Dimming Control Stage

The condition for full dimming is when the V_{dm} voltage is 2V and the condition for full lighting is when the V_{dm} voltage is 0V. Dimming operation starts when V_{cs} becomes 4V and the change rate of dimming is determined by the capacitor connected to the Cdm pin. The more smooth dimming can be accomplished by the larger capacitor connected to the Cdm pin. If the V_{dm} pin voltage is higher than 5V, then the output drive stage remains in off state. Dimming control and output drive on/off control can be achieved with only one pin.

Output Drive Stage

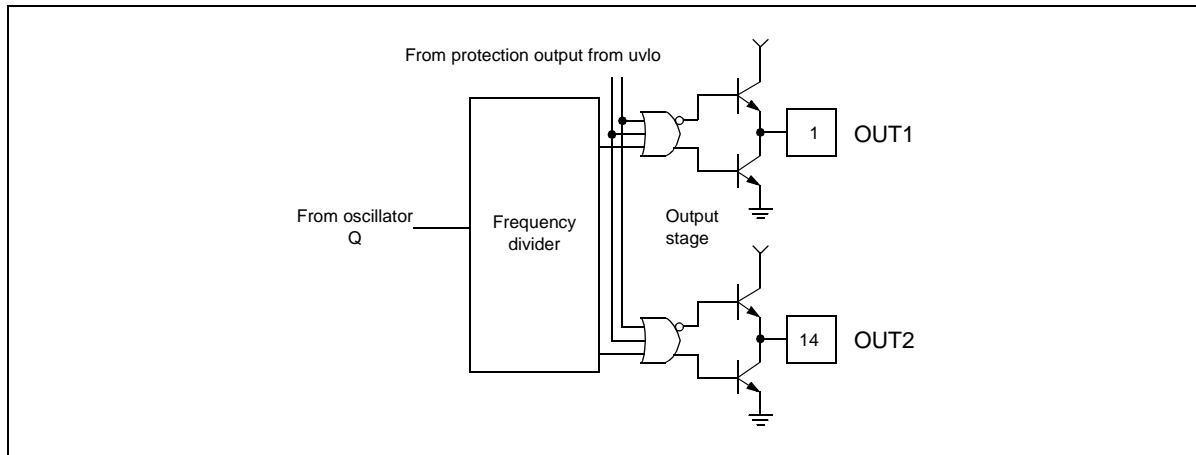


Figure 6. Output Drive Stage

OUT1 and OUT2 are complementary and there is 1.4μs dead time for the ZVS operation. The structure of output stage is the totem-pole output stage. For the high side MOSFET drive, a pulse transformer is necessary.

No Lamp Protection

If the V_{ld} pin voltage is lower than 1V, it means that there is no lamp connected. On no lamp condition, the output drive stage is in off state.

Abnormal Protection

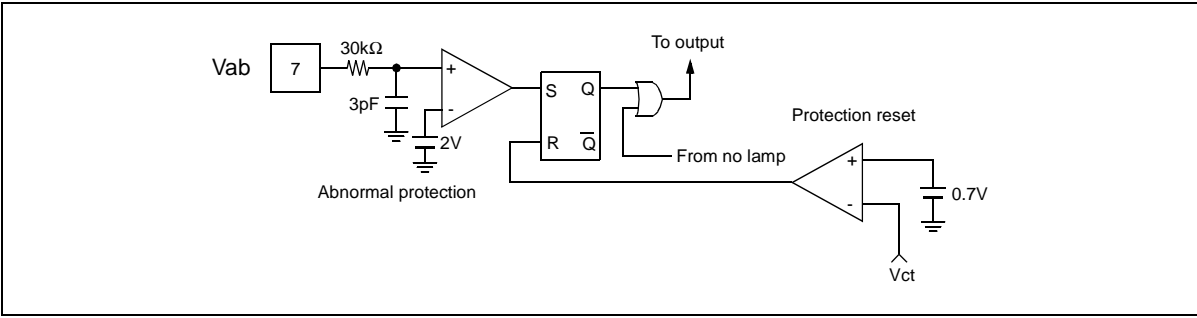


Figure 7. Abnormal Protection Circuit

The abnormal protection is similar to the over current protection, but it is a protection that detects abnormal connection of lamps. The abnormal protection circuit works when the Vab pin voltage is higher than 2V. The abnormal protection is latched using a flip-flop and the protection is reset when the ballast system restarts.

Lamp Selector Stage

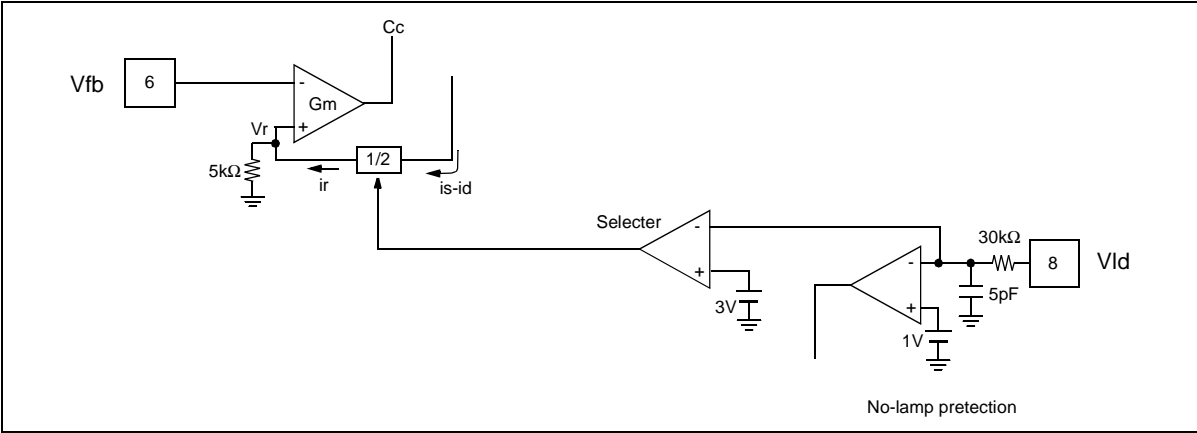
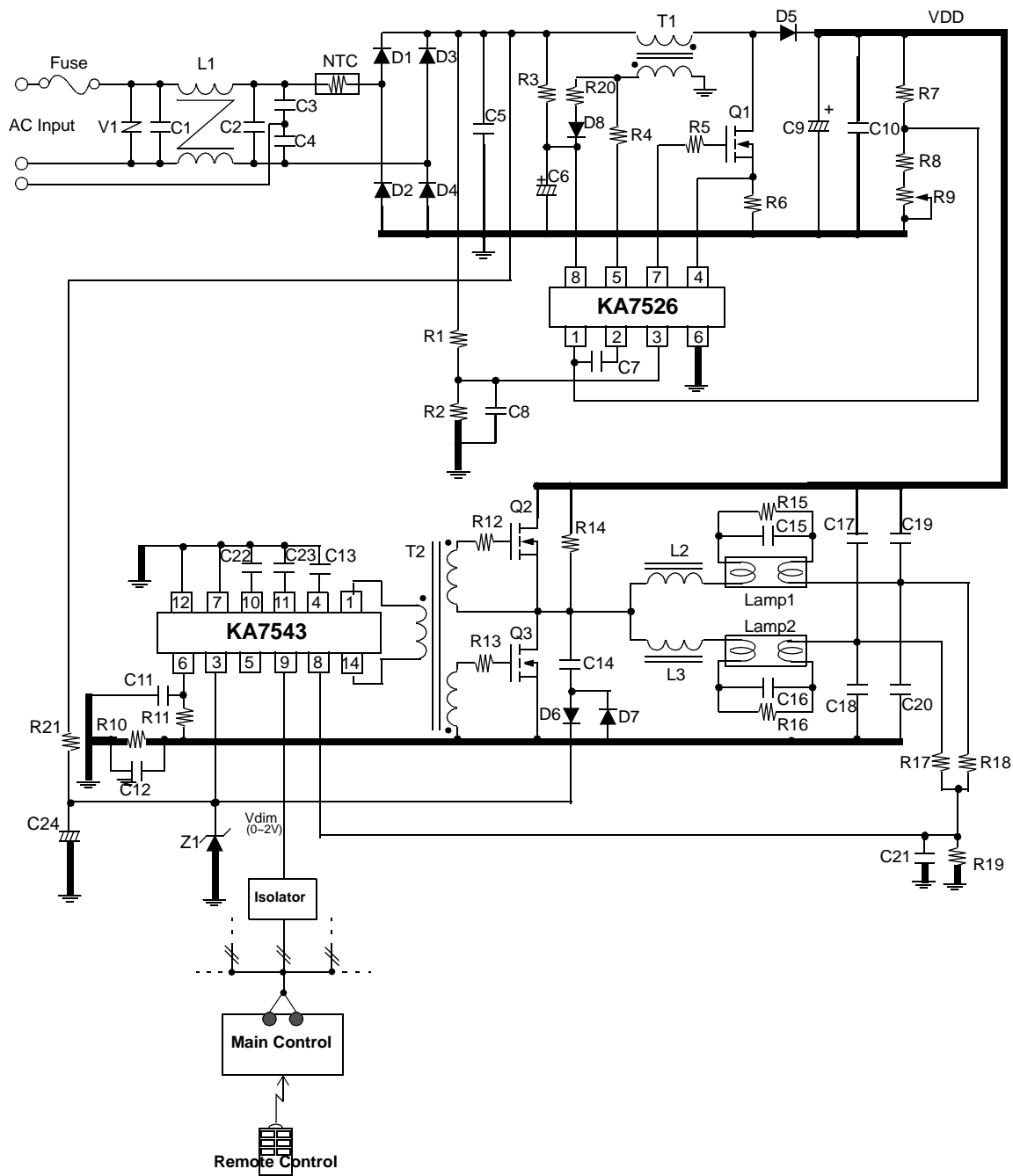


Figure 8. Lamp Selector Stage

If the Vld pin voltage is between 1V and 3V, it means that there is one lamp connected and if the Vld pin voltage is over 3V, it is two lamps condition. The feedback reference voltage of the two lamps condition is twice that of one lamp condition.

Application Circuit

<85 ~ 265VAC Input, 400VDC, Fluorescent Lamps Ballast(32W*2 / 36W*2 / 40W*2)>



Components List (32w*2Lamp Application)

Reference	Value	Part number	Manufacturer
R1	2.2M Ω -F, 1/4W	-	-
R2,4,11	22k Ω -F, 1/4W	-	-
R3,21	150k Ω -J, 1/2W	-	-
R5, 12, 13	47 Ω -J, 1/4W	-	-
R6	1 Ω -J, 1W	-	-
R7	1.2M Ω -F, 1/4W	-	-
R8	7k Ω -F, 1/4W	-	-
R9	1k Ω Variable Resistor	-	-
R10	6.2 Ω -J, 1W	-	-
R14	180k Ω -J, 1/4W	-	-
R15, R16	330k Ω -J, 1/4W	-	-
R17, R18	680k Ω -J, 1/4W	-	-
R19	8.2k Ω -J, 1/4W	-	-
R20	3.3 Ω -J, 1/4W	-	-
C1, 2	0.15 μ F, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1 μ F, 630V	Miller-CAP	-
C6,24	47 μ F, 35V	Electrolytic	-
C7	0.33 μ F, 25V	Ceramic	-
C8	0.01 μ F, 25V	Ceramic	-
C9	47 μ F, 450V	Electrolytic	-
C10	0.22 μ F, 630V	Miller-CAP	-
C11,12,13	0.1 μ F, 25V	Ceramic	-
C14	1nF, 630V	Miller-CAP	-
C15, 16	4700pF, 1000V	Miller-CAP	-
C17, 19	4700pF, 630V	Miller-CAP	-
C18, 20	6800pF, 630V	Miller-CAP	-
C21	0.1 μ F, 25V	Ceramic	-
C22	4.7 μ F, 35V	Electrolytic	-
C23	22 μ F, 35V	Electrolytic	-
D1, 2, 3, 4	1000V, 1A	1N4007	-

Components List(32w*2Lamp Application) (Continue)

Reference	Value	Part number	Manufacturer
D5	FRD(25nS)	BYV26C	Philips
D6,7	1000V, 1.5A	1N4937	-
D8	75V, 150mA	1N4148	-
L1	80mH	BSF2125	-
T1	1.2mH(100T:5T) Litz or USTC Wire	EI2820	-
L2, 3	3.1mH Litz or USTC Wire	EI2820	-
T2	1.2mH(35T:35T:35T)	EE1614	-
Fuse	-	52NM250V, 3A	-
V1	430V	INR140, 431	-
Z1	15V,1W	-	-
Q1, 2, 3	500V, 6A	QFP6N50	FairChild
Isolator	Dimming Solution	-	E.M
Main Control	Dimming Solution	-	E.M
Remote Control	Dimming Solution	-	E.M

Components List(36w*2Lamp Application)

Reference	Value	Part number	Manufacturer
R1	2.2M Ω -F, 1/4W	-	-
R2,4,11	22k Ω -F, 1/4W	-	-
R3	150k Ω -J, 1/2W	-	-
R5, 12, 13	47 Ω -J, 1/4W	-	-
R6	1 Ω -J, 1W	-	-
R7	1.2M Ω -F, 1/4W	-	-
R8	7k Ω -F, 1/4W	-	-
R9	1k Ω Variable Resistor	-	-
R10	5.8 Ω -J, 1W	-	-
R14	180k Ω -J, 1/4W	-	-
R15, R16	330k Ω -J, 1/4W	-	-
R17, R18	680k Ω -J, 1/4W	-	-
R19	8.2k Ω -J, 1/4W	-	-
R20	3.3 Ω -J, 1/4W	-	-
C1, 2	0.15 μ F, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1 μ F, 630V	Miller-CAP	-
C6,24	47 μ F, 35V	Electrolytic	-
C7	0.33 μ F, 25V	Ceramic	-
C8	0.01 μ F, 25V	Ceramic	-
C9	47 μ F, 450V	Electrolytic	-
C10	0.22 μ F, 630V	Miller-CAP	-
C11,12,13	0.1 μ F, 25V	Ceramic	-
C14	1nF, 630V	Miller-CAP	-
C15, 16	4700pF, 1000V	Miller-CAP	-
C17, 19	4700pF, 630V	Miller-CAP	-
C18, 20	4700pF, 630V	Miller-CAP	-
C21	0.1 μ F, 25V	Ceramic	-
C22	4.7 μ F, 35V	Electrolytic	-
C23	22 μ F, 35V	Electrolytic	-
D1, 2, 3, 4	1000V, 1A	1N4007	

Components List(36w*2Lamp Application) (Continue)

Reference	Value	Part number	Manufacturer
D5	FRD(25nS)	BYV26C	Philips
D6,7	1000V, 1.5A	1N4937	-
D8	75V, 150mA	1N4148	-
L1	80mH	BSF2125	-
T1	1.2mH(100T:5T) Litz or USTC Wire	EI2820	-
L2, 3	2,8mH Litz or USTC Wire	EI2820	-
T2	1.2mH(35T:35T:35T)	EE1614	-
Fuse	-	52NM250V, 3A	-
V1	430V	INR140, 431	-
Z1	15V,1W	-	-
Q1, 2, 3	500V, 6A	QFP6N50	FairChild
Isolator	Dimming Solution	-	E.M
Main Control	Dimming Solution	-	E.M
Remote Control	Dimming Solution	-	E.M

Components List(40w*2Lamp Application)

Reference	Value	Part number	Manufacturer
R1	2.2M Ω -F, 1/4W	-	-
R2,4,11	22k Ω -F, 1/4W	-	-
R3,21	150k Ω -J, 1/2W	-	-
R5, 12, 13	47 Ω -J, 1/4W	-	-
R6	1 Ω -J, 1W	-	-
R7	1.2M Ω -F, 1/4W	-	-
R8	7k Ω -F, 1/4W	-	-
R9	1k Ω Variable Resistor	-	-
R10	5.6 Ω -J, 1W	-	-
R14	180k Ω -J, 1/4W	-	-
R15, R16	330k Ω -J, 1/4W	-	-
R17, R18	680k Ω -J, 1/4W	-	-
R19	8.2k Ω -J, 1/4W	-	-
R20	3.3 Ω -J, 1/4W	-	-
C1, 2	0.15 μ F, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1 μ F, 630V	Miller-CAP	-
C6,24	47 μ F, 35V	Electrolytic	-
C7	0.33 μ F, 25V	Ceramic	-
C8	0.01 μ F, 25V	Ceramic	-
C9	47 μ F, 450V	Electrolytic	-
C10	0.22 μ F, 630V	Miller-CAP	-
C11,12,13	0.1 μ F, 25V	Ceramic	-
C14	1nF, 630V	Miller-CAP	-
C15, 16	4700pF, 1000V	Miller-CAP	-
C17, 19	4700pF, 630V	Miller-CAP	-
C18, 20	4700pF, 630V	Miller-CAP	-
C21	0.1 μ F, 25V	Ceramic	-
C22	4.7 μ F, 35V	Electrolytic	-
C23	22 μ F, 35V	Electrolytic	-
D1, 2, 3, 4	1000V, 1A	1N4007	-

Components List(40w*2Lamp Application) (Continue)

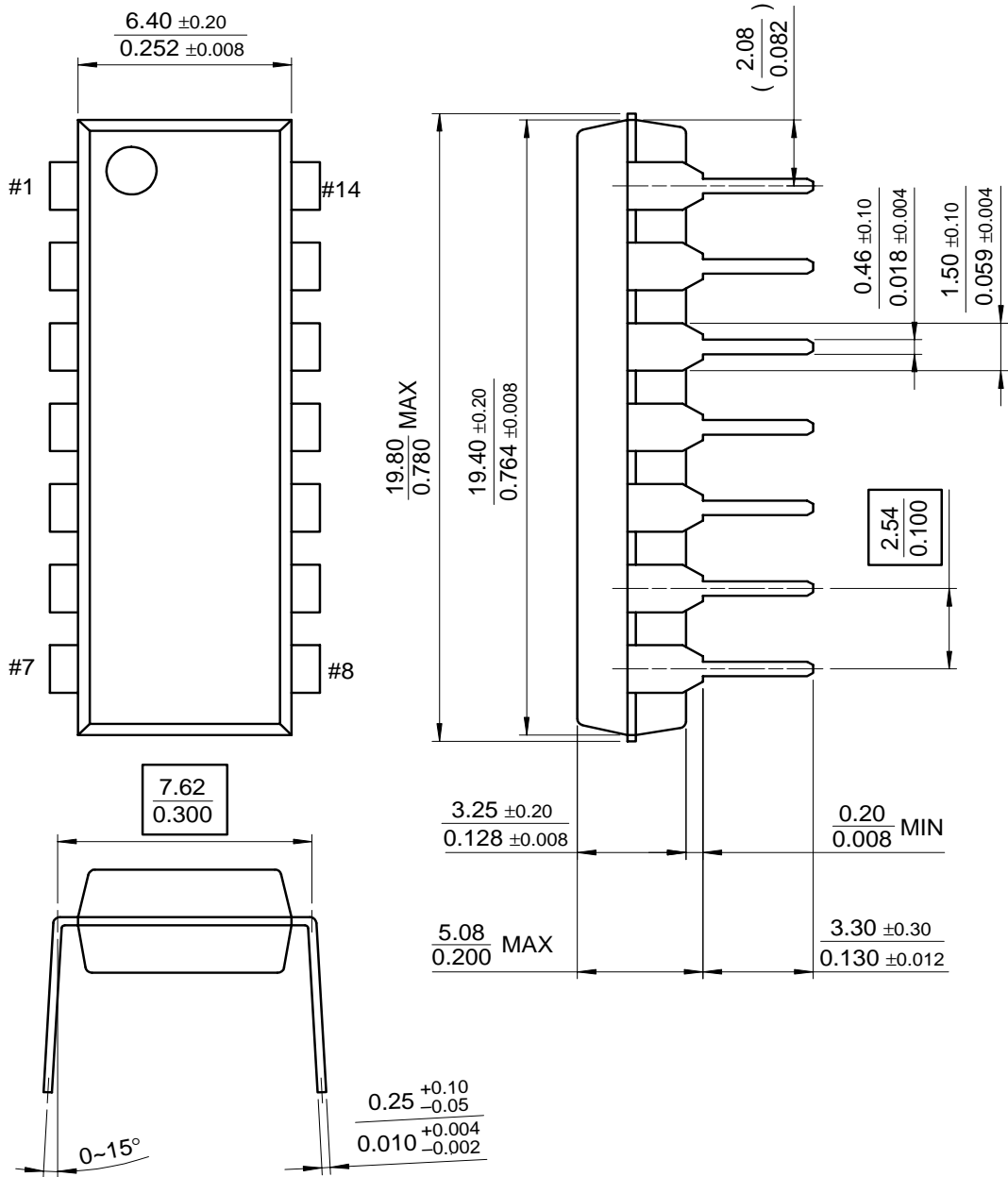
Reference	Value	Part number	Manufacturer
D5	FRD(25nS)	BYV26C	Philips
D6,7	1000V, 1.5A	1N4937	-
D8	75V, 150mA	1N4148	-
L1	80mH	BSF2125	-
T1	1.2mH(100T:5T) Litz or USTC Wire	EI2820	-
L2, 3	2,75mH Litz or USTC Wire	EI2820	-
T2	1.2mH(35T:35T:35T)	EE1614	-
Fuse	-	52NM250V, 3A	-
V1	430V	INR140, 431	-
Z1	15V,1W	-	-
Q1, 2, 3	500V, 6A	QFP6N50	FairChild
Isolator	Dimming Solution	-	E.M
Main Control	Dimming Solution	-	E.M
Remote Control	Dimming Solution	-	E.M

Mechanical Dimensions

Package

Dimensions in millimeters

14-DIP

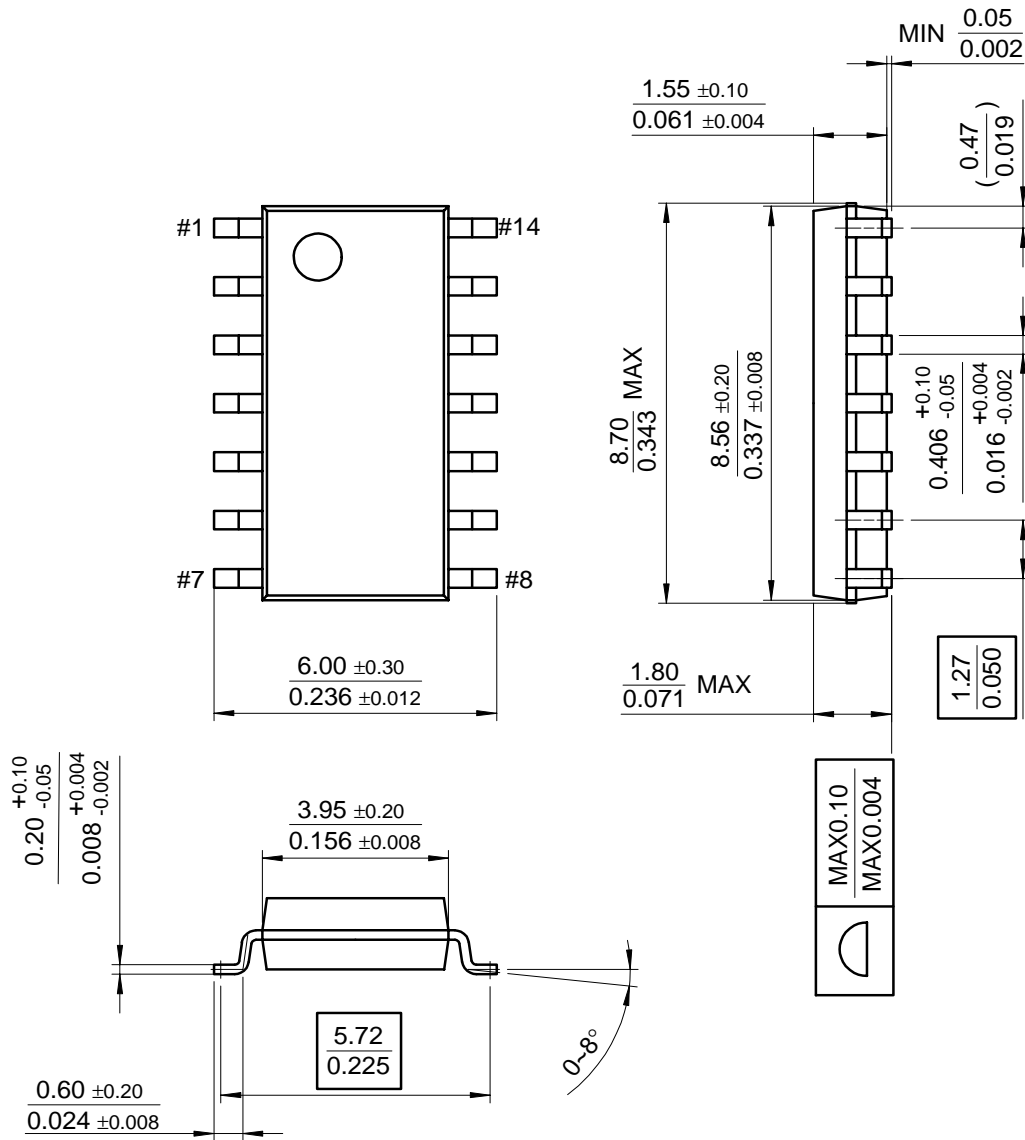


Mechanical Dimensions (Continued)

Package

Dimensions in millimeters

14-SOP



Ordering Information

Product Number	Package	Operating Temperature
KA7543	14-DIP	-25°C ~ +85°C
KA7543D	14-SOP	

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.