KA7543

Advanced Feedback Dimming Ballast Control IC

Features

- Lamp Current Feedback
- Soft Start on Feedback
- Voltage Dimming (0V~2V) on Feedback
- Switch off Control (Vdm=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

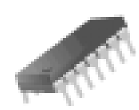
Applications

- 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.

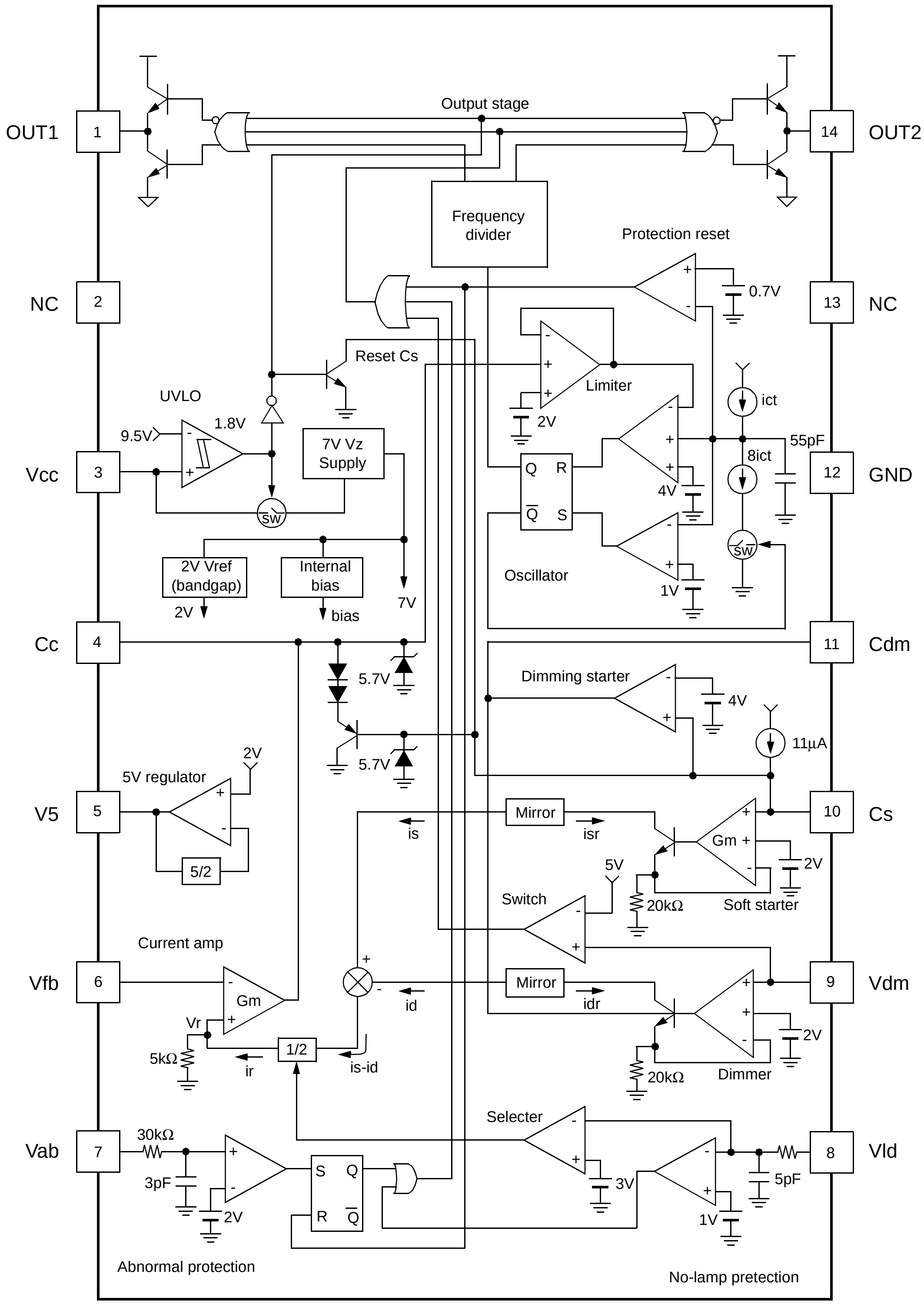
14-DIP



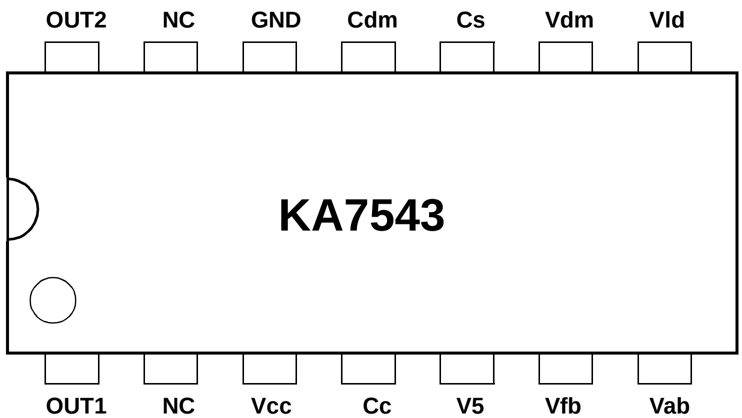
14-SOP

Rev. 1.0.3

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 $V_O < -0.3$	Iclamp	±10	mA
Operating Temperature Range	Topr	-25 to 125	°C
Storage Temperature Range	Tstg	-65 to 150	°C
Power Dissipation	Pd	1	W
Thermal Resistance (Junction-to-Air)	θja	123	°C/W

Absolute Maximum Ratings (–25°C≤Ta≤125°C)

Parameter	Symbol	Value	Unit
Temperature Stability For Reference Voltage (Vref)	ΔVref(Typ)	20	mV
Temperature Stability For Operating Frequency (fs)	Δfs(Typ)	8	kHz

Electrical Characteristics

Unless otherwise specified, Vcc=12V, Ta=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)	V5	I5 = 0mA	4.9	5	5.1	V
SUPPLY CURRENT SECTION						
Start Up Supply Current	I_{ST}	Vcc=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}	fo = 50kHz, Cl=1nF	-	8	12	mA
CURRENT AMPLIFIER SECTION (NOTE1)						
Output Sink Current	Iea(i)	Vfb = 2V	12	15	18	μA
Output Source Current	Iea(o)	Vfb = 0V	12	15	18	μA

Electrical Characteristics (Continue)

Unless otherwise specified, Vcc=12V, Ta=25°C.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
1 Lamp Feedback Voltage	Vfb1	Vld = 2V	0.425	0.5	0.575	V
2 Lamp Feedback Voltage	Vfb2	Vld = 4V	0.85	1	1.15	V
Output Voltage High	Vea(h)	Vfb = 0V	5.5	5.7	5.9	V
Output Voltage Low	Vea(l)	Vfb = 2V	-	-	0.4	V
OSCILLATOR SECTION(NOTE1)						
Reference Frequency	fref	V_C = 3.0V	37	45	53	kHz
Reference Dead Time	td	V_C = 3.0V	1.2	1.4	1.6	μs
Soft Start Frequency	fss	V_C = 0V	77	-	-	kHz
Soft Start Time Current	I_{SS}	V_C = 0V	9.2	11	12.8	μA
VOLTAGE INPUT DIMMING SECTION(NOTE1)						
Dimming Voltage Range	ΔVdm	-	0	-	2	V
Dimming Start Voltage	Vdm	Vdm = 0V	3.85	4	4.15	V
Initial Dimming Output Voltage	Vdm	Vdm = 0V	-0.1	0	0.1	V
OUTPUT 1/2 SECTION						
Rising Time (Note2)	tr	Vcc =12V,Cl =1nF	-	200	280	ns
Falling Time(Note2)	tf	Vcc =12V,Cl =1nF	-	50	90	ns
Output Voltage With UVLO Activated	Vomin(o)	V_{CC} = 5V, I_O =100μA	-	-	0.9	V
PROTECTION SECTION						
Lamp Detection Voltage	Vld	-	2.5	3	3.5	V
Abnormal Detection Voltage	Vab	-	1.6	2	2.4	V
Switch Off Detection Voltage	Vso	-	4.7	5	5.3	V
No Lamp Detect Voltage	Vnd	-	0.85	1	1.15	V
PROTECTION RESET SECTION						
Protection Reset Voltage	Vpr	-	-	0.7	-	V

Notes :

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

Operating Description

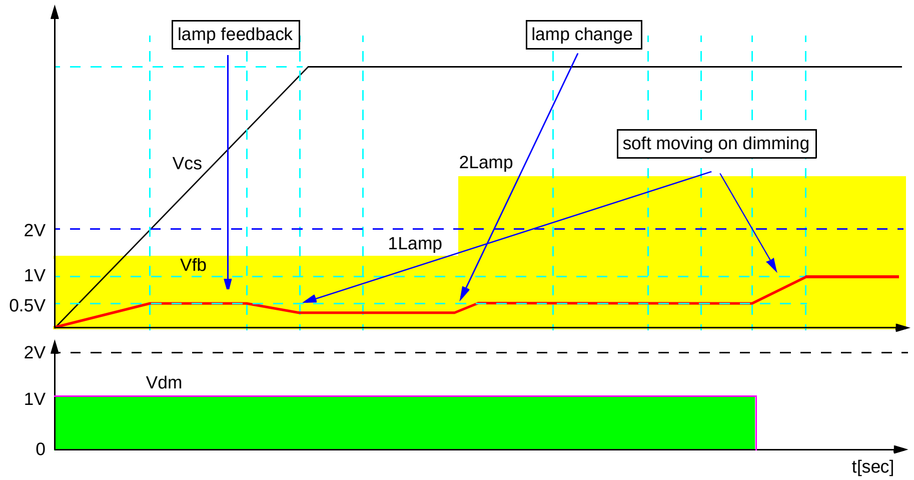


Figure 1. Operation Characteristics

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 Vcc voltage reaches the start-up threshold voltage(9.5V), the soft start capacitor begins to be charged. When the Cs pin voltage, Vcs is over 2V, the soft start operation ends. During the soft start operation, the reference voltage which controls the lamp current is proportional to Vcs. Dimming operation starts when Vcs 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.

UVLO(Under Voltage Lock Out)

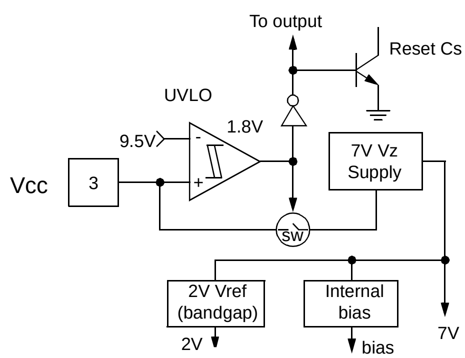


Figure 2. UVLO

Until the Vcc voltage reaches the start-up threshold voltage(9.5V), UVLO circuit lowers the IC operating current below 270µA. When the Vcc voltage reaches the start-up threshold voltage, it generates IC reference voltage(Vref) and supplies bias current for the whole circuitry. The hysteresis of UVLO circuit is 1.8V.

Soft Start

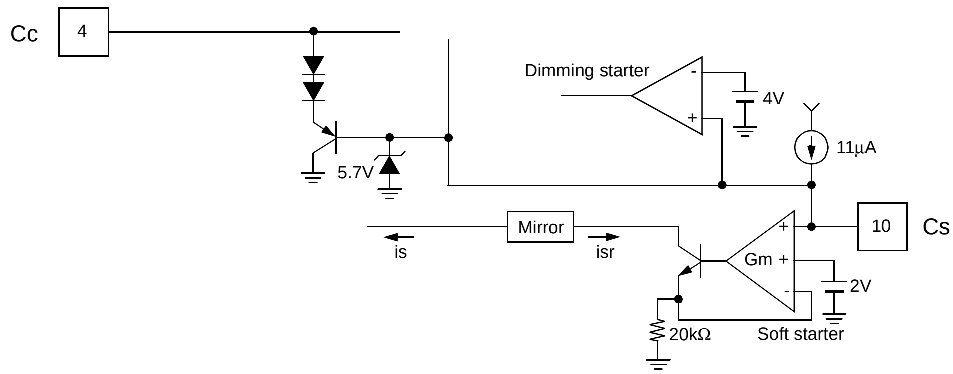


Figure 3. Soft Start

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(is) makes the reference voltage(Vr) which is proportional to is current. The is current is maximum when the Cs pin voltage is 2V. The highest soft start frequency is determined by the Cc pin voltage(Vbe+2Vd). 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 Vcs. 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 Vcc voltage is lower than UV.

Oscillator

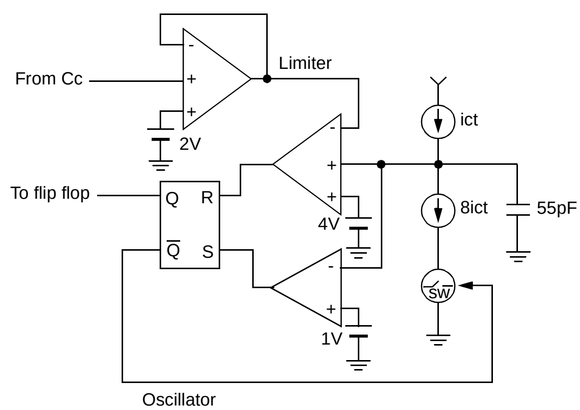


Figure 4. Oscillator

The oscillator block consists of two comparators and the ratio of charging time and discharging time is 7:1. The current source, ict charges 55pF capacitor until the capacitor voltage meets the upper limit voltage. After that time, 7*ict current discharges the capacitor until it meet 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

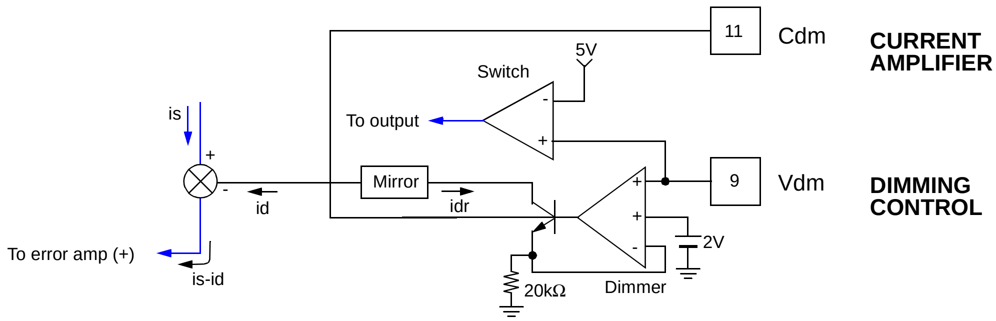


Figure 5. Dimming Control Stage

The condition for full dimming is when the Vdm voltage is 2V and the condition for full lighting is when the Vdm voltage is 0V. Dimming operation starts when Vcs 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 Vdm 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

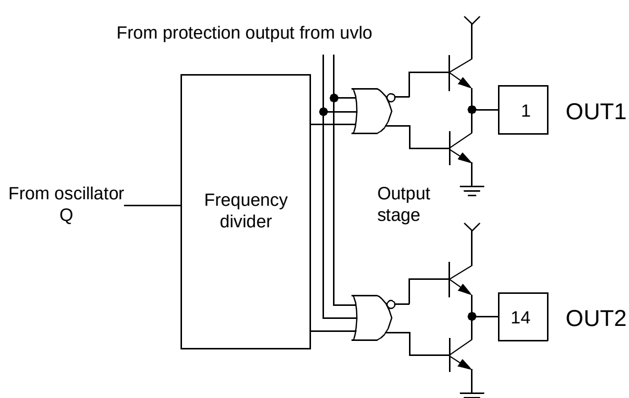


Figure 6. Output Drive Stage

OUT1 and OUT2 are complementary and there is 1.4us 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 Vld 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

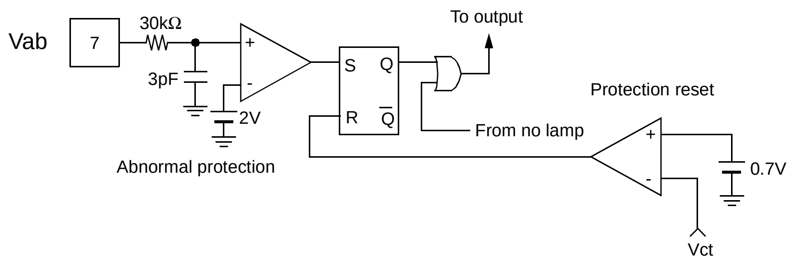


Figure 7. Abnormal Protection Circuit

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

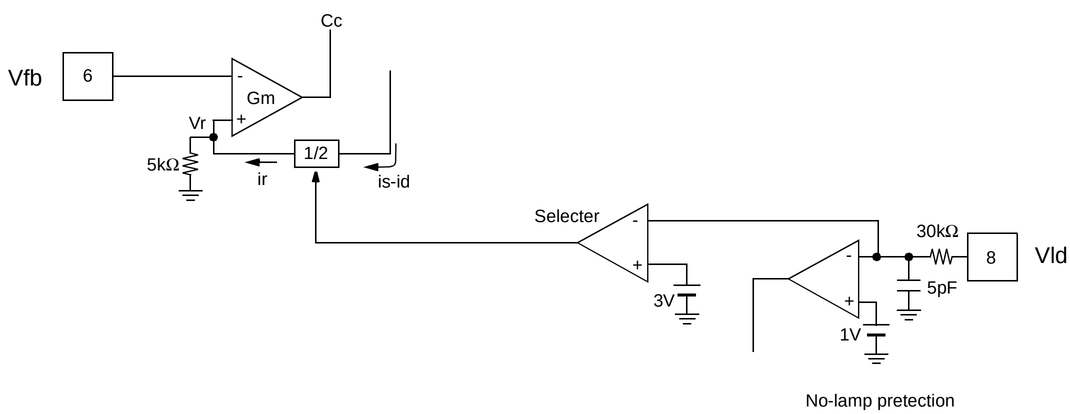
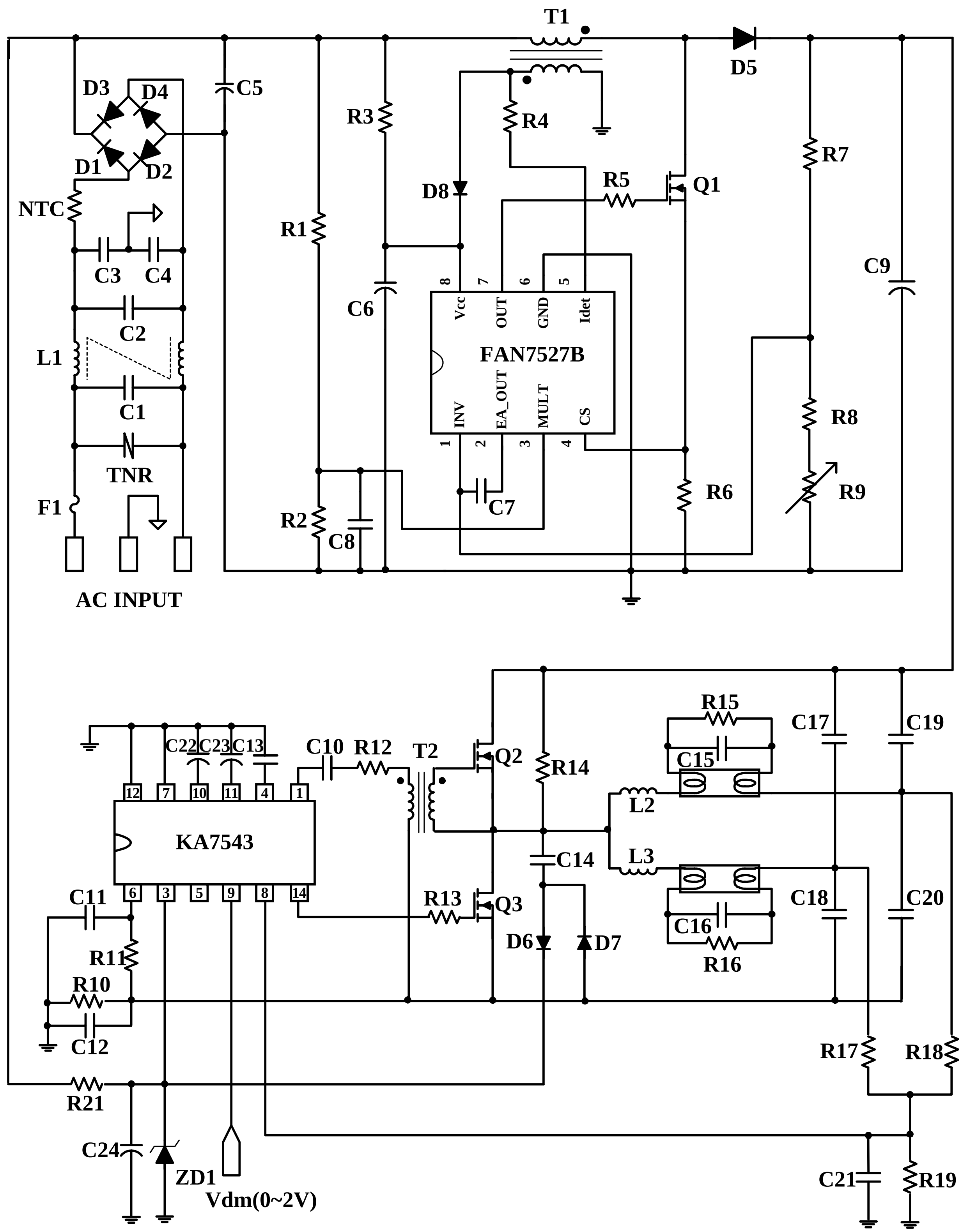


Figure 8. Lamp Selector Stage

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 ~ 265V_{AC} Input, 400V_{DC}, Fluorescent Lamps Ballast(32W*2 / 36W*2)>



Components List (32W*2Lamp Application)

Part Number	Value	Note	Manufacturer
R1	1.8MΩ	1/4W	-
R2	25kΩ	1/4W	-
R3, 21	150kΩ	1W	-
R4, 11	22kΩ	1/4W	-
R5	10Ω	1/4W	
R6	0.68Ω	1W	-
R7	1.0MΩ	1/4W	-
R8	6kΩ	1/4W	-
R9	103	Variable resistor	-
R10	6.8Ω	1W	-
R12, 13	47Ω	1W	-
R14	180kΩ	1/4W	-
R15, 16	330kΩ	1/4W	-
R17, 18	680kΩ	1/4W	-
R19	8.2kΩ	1/4W	-
C1, 2	150nF, 275Vac	Box-Cap	-
C3, 4	2200pF, 3000V	Y-Cap	-
C5	0.33µF, 630V	Miller-Cap	-
C6, 24	47µF, 35V	Electorlytic	-
C7	1µF	MLCC	-
C8, 11	1nF, 25V	Ceramic	-
C9	47µF, 450V	Electorlytic	-
C10	0.22µF, 25V	Ceramic	-
C12, 21	0.1µF, 25V	Ceramic	-
C13	10nF, 25V	Ceramic	-
C14	1nF, 630V	Miller-Cap	-
C15,16	4700pF, 1000V	Miller-Cap	-
C17, 18, 19, 20	6800pF, 630V	Miller-Cap	-
C22, 23	22µF, 35V	Electorlytic	-
Q1, 2, 3	500V, 4.5A	IRFS830B	Fairchild
D1, 2, 3, 4	1000V, 1A	1N4007	-
D5	600V, 1A	BYV26C	-
D6, 7	600V, 1A	1N4937	-
D8	75V, 150mA	1N4148	-
ZD1	15V, 1W	1N4744	-
L1	45mH	Line Filter	-
L2, 3	3.1mH(120T)	EI2820	-
T1	0.9mH(80T:6T)	EI2820	-
T2	1.2mH(30T:60T)	EE1614	-
F1	250V, 3A	Fuse	-
TNR	470V	471	-
NTC	10Ω	10D09	-

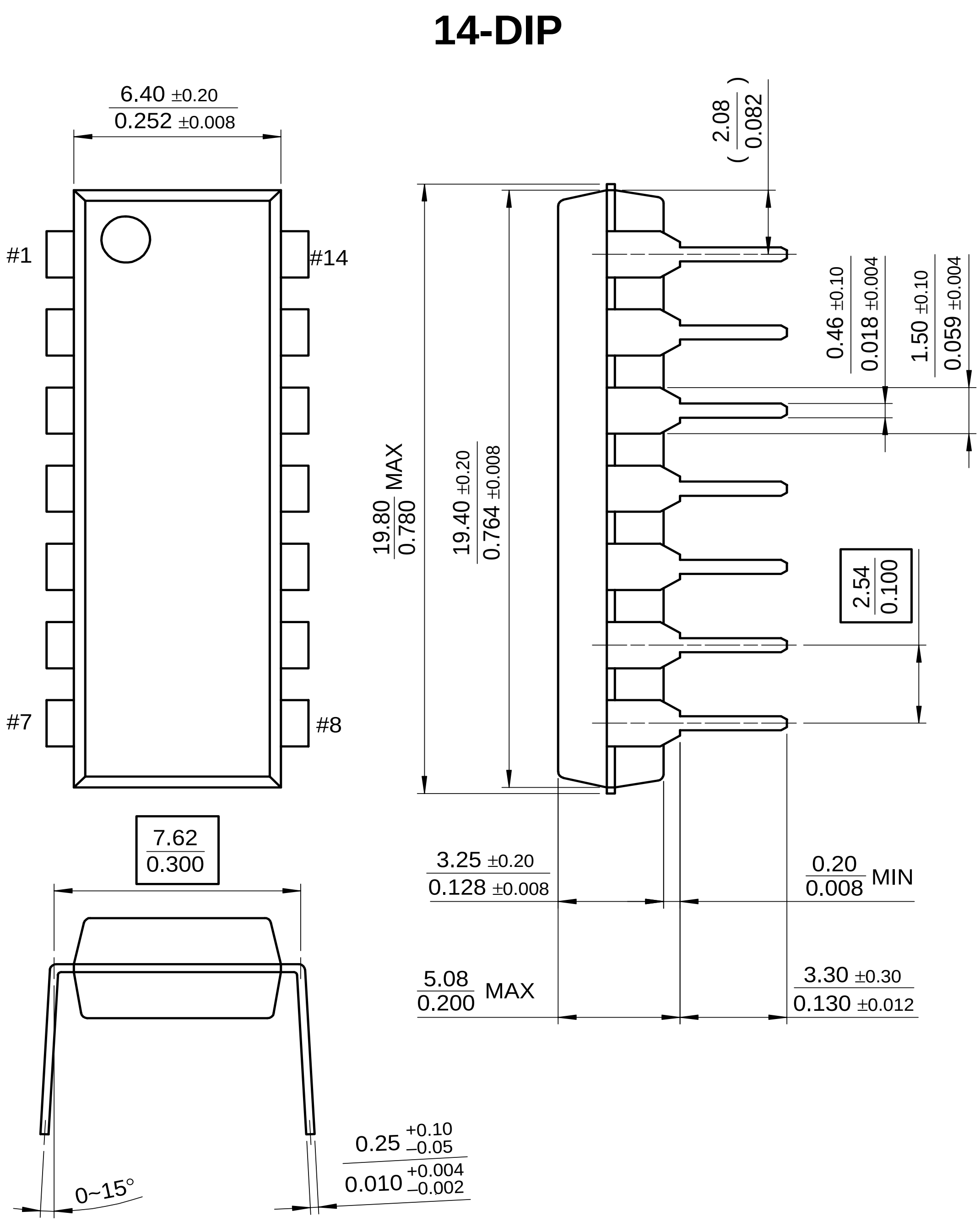
Components List(36W*2Lamp Application) (Continued)

Part Number	Value	Note	Manufacturer
R1	1.8MΩ	1/4W	-
R2	22kΩ	1/4W	-
R3, 21	150kΩ	1W	-
R4, 11	22kΩ	1/4W	-
R5	10Ω	1/4W	
R6	0.68Ω	1W	-
R7	1MΩ	1/4W	-
R8	6kΩ	1/4W	-
R9	103	Variable resistor	-
R10	6.8Ω	1W	-
R12, 13	47Ω	1W	-
R14	180kΩ	1/4W	-
R15, 16	330kΩ	1/4W	-
R17, 18	680kΩ	1/4W	-
R19	8.2kΩ	1/4W	-
C1, 2	150nF, 275Vac	Box-Cap	-
C3, 4	2200pF, 3000V	Y-Cap	-
C5	0.33µF, 630V	Miller-Cap	-
C6, 24	47µF, 35V	Electorlytic	-
C7	1µF	MLCC	-
C8, 11	1nF, 25V	Ceramic	-
C9	47µF, 450V	Electorlytic	-
C10	0.22µF, 25V	Ceramic	-
C12, 21	0.1µF, 25V	Ceramic	-
C13	10nF, 25V	Ceramic	-
C14	1nF, 630V	Miller-Cap	-
C15,16	3300pF, 1000V	Miller-Cap	-
C17, 18, 19, 20	6800pF, 630V	Miller-Cap	-
C22, 23	22µF, 35V	Electorlytic	-
Q1, 2, 3	500V, 4.5A	IRFS830B	Fairchild
D1, 2, 3, 4	1000V, 1A	1N4007	-
D5	600V, 1A	BYV26C	-
D6, 7	600V, 1A	1N4937	-
D8	75V, 150mA	1N4148	-
ZD1	15V, 1W	1N4744	-
L1	45mH	Line Filter	-
L2, 3	3.1mH(120T)	EI2820	-
T1	0.9mH(80T:6T)	EI2820	-
T2	1.2mH(30T:60T)	EE1614	-
F1	250V, 3A	Fuse	-
TNR	470V	471	-
NTC	10Ω	10D09	-

Mechanical Dimensions

Package

Dimensions in millimeters

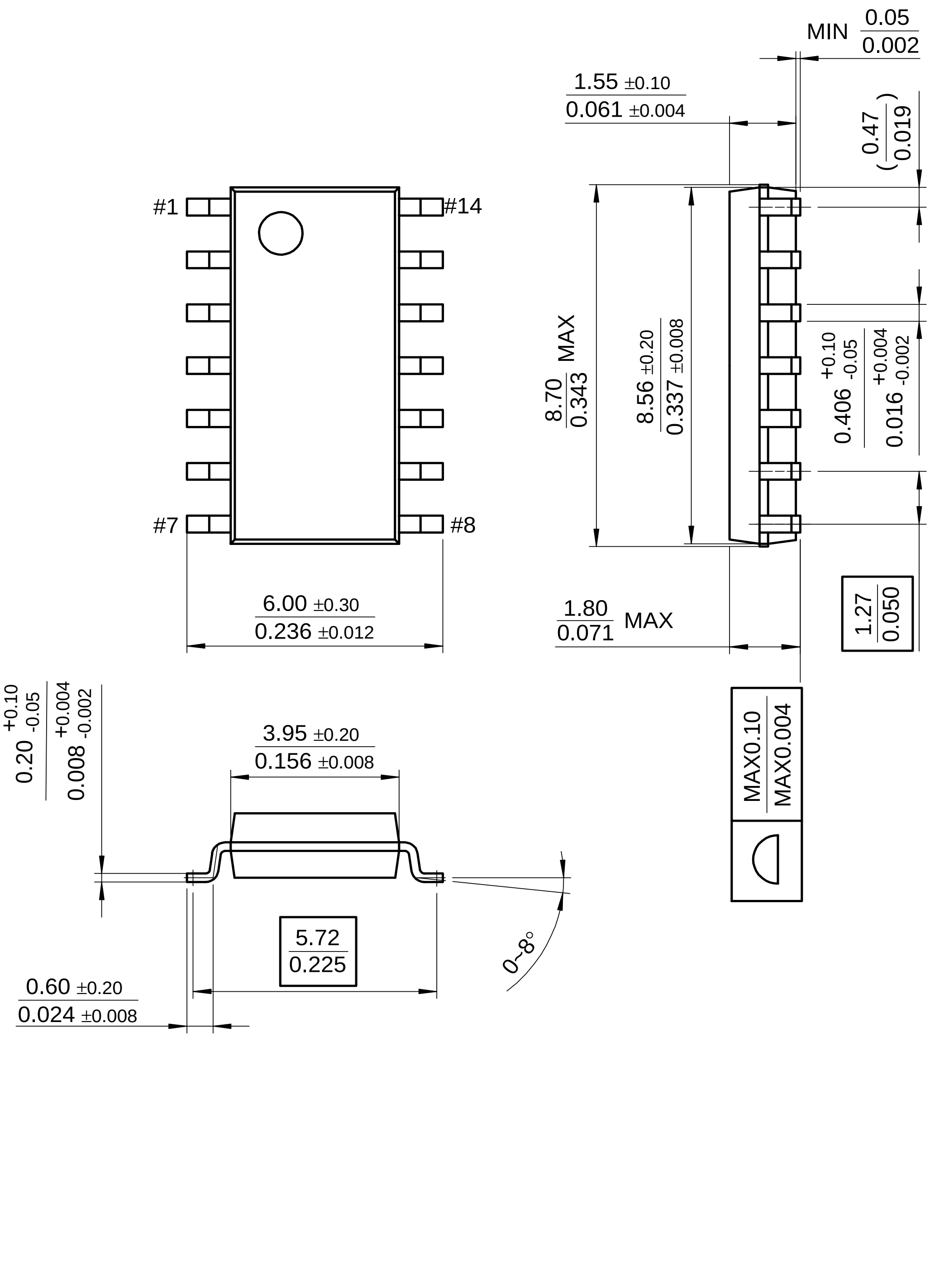


Mechanical Dimensions (Continued)

Package

Dimensions in millimeters

14-SOP



Ordering Information

Product Number	Package	Operating Temperature
KA7543	14-DIP	-25°C ~ +125°C
KA7543D	14-SOP	

8/2/02 0.0m 001
Stock#DSxxxxxxxx