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
- 14DIP & 14SOP

Applications

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

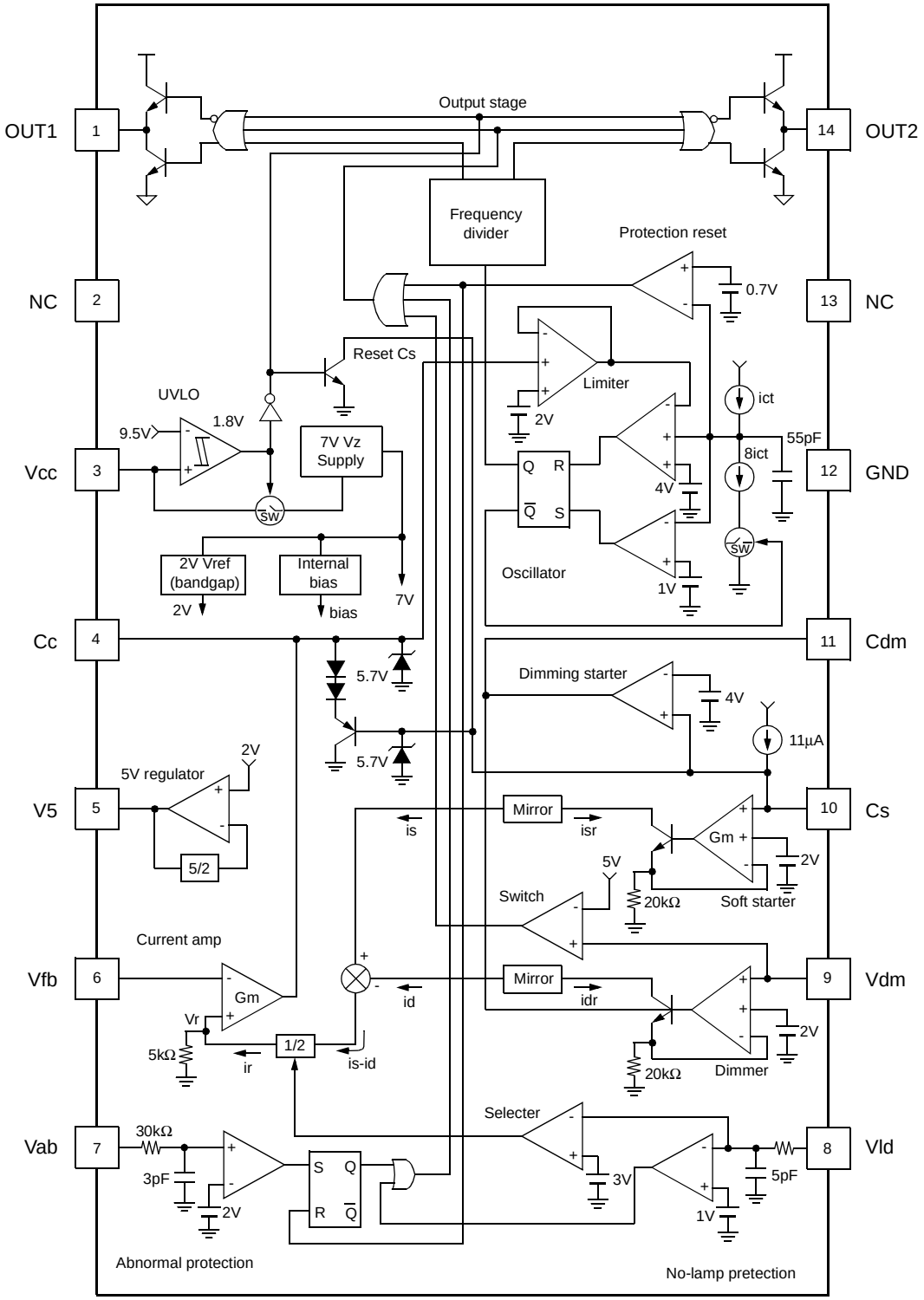
Descriptions

The KA7543 is an advanced-lamp current feedback dimming control IC. This feedback dimming ballast control IC provides all of the necessary features to implement wide dimming range control, soft-start and constant power consumption for intelligent electronic ballast systems. The KA7543 is optimized for advanced electronic ballast systems requiring a 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 an 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 function,have been added.

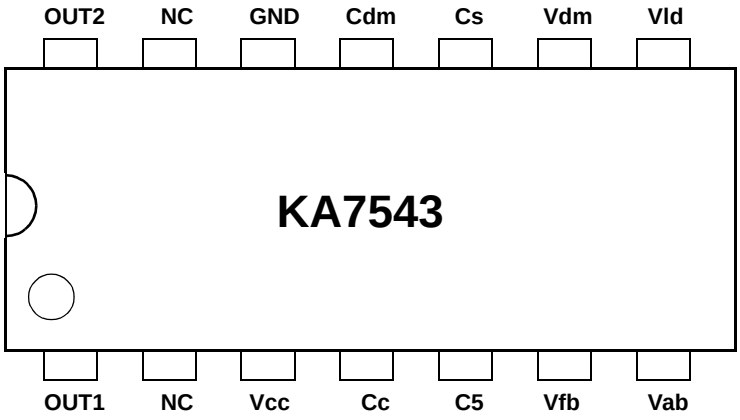
14-DIP

14-SOP

Internal Block Diagram



Pin Assignments



Pin Definitions

Pin Number	Pin Name	Pin Function Descrition
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 85	°C
Storage temperature range	Tstg	–65 to 150	°C
Power dissipation	Pd	0.8	W
Thermal resistance (Junction-to-air)	θja	100	W / °C

Absolute Maximum Ratings (–25°C≤Ta≤85°C)

Parameter	Symbol	Value	Unit
Temperature stability for reference voltage (Vref)	ΔVref (Typ)	15	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, CI=1nF	-	8	12	mA
CURRENT AMPLIFIER SECTION(Note 1)						
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(Note 1)						
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(Note 1)						
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,CI=1nF	-	200	280	ns
Falling time(Note2)	tf	Vcc=12V,CI=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

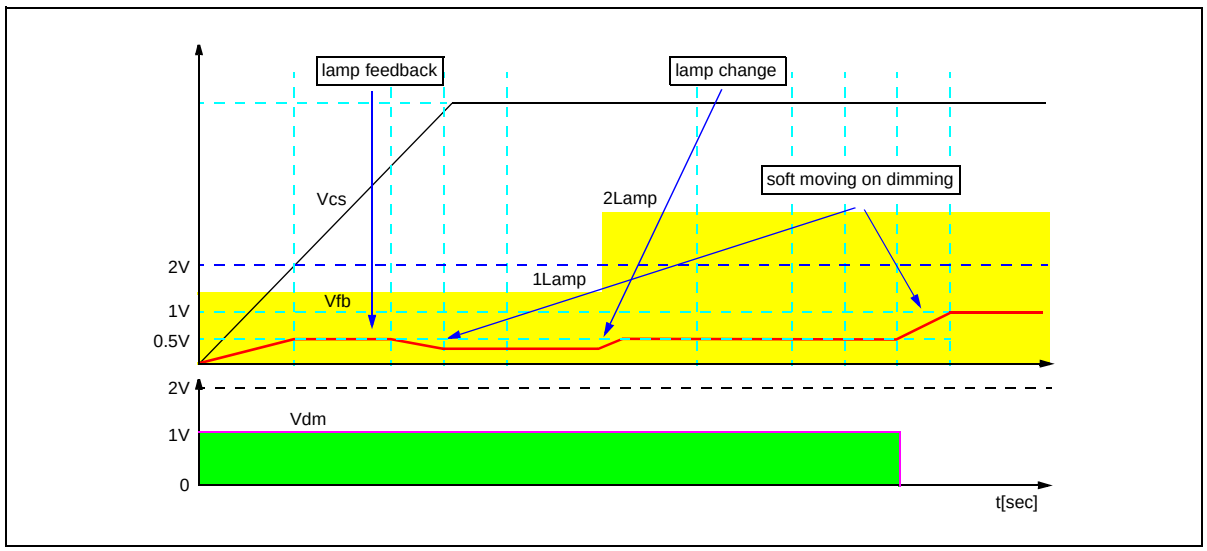


Figure 1. Operation Characteristics

The KA7543 is an advanced-lamp current feedback dimming control IC. This feedback dimming ballast control IC provides all of the necessary features to implement wide dimming range control, soft-start and constant power consumption for intelligent electronic ballast systems. The KA7543 is optimized for advanced electronic ballast systems requiring a 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 an 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 function,have been added.

Uvlo(Under Voltage Lock Out)

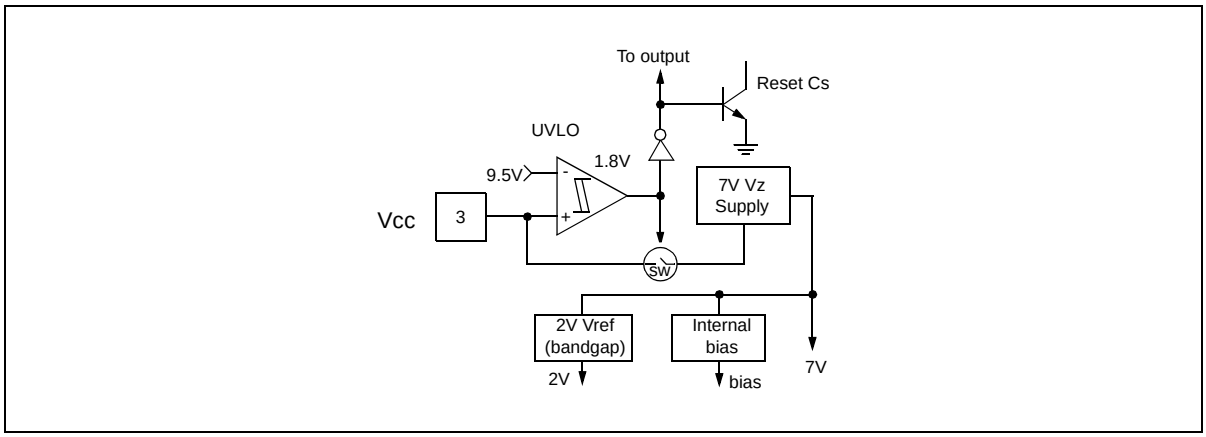


Figure 2. UVLO

Until the Vcc reaches the start-up threshold voltage (9.5V), UVLO circuit supplies low start-up current (Max 270μA). When it reaches the start-up threshold voltage (9.5V), it gives reference voltage (Vref) and bias current for whole circuitary.

Soft Start

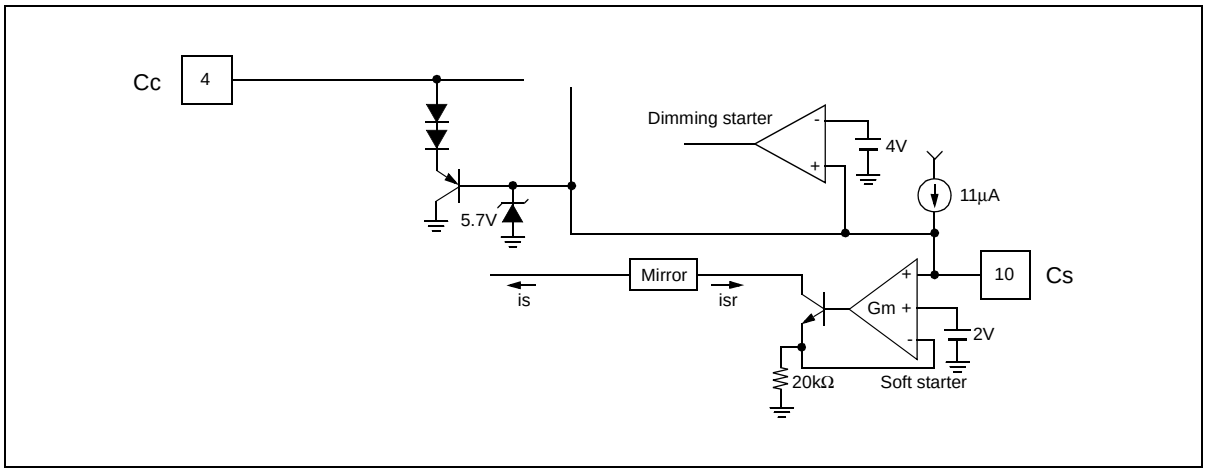


Figure 3. Soft Start

Soft start circuit charges the soft start current to soft start capacitor Cs. So its voltage linieary increase and the current(Is) creates the reference voltage(Vr). Maximum high soft start frequency is determined by Cc voltage(Vbe+2Vd). the soft-start frequency lineary decrease until the Vcs reaches 2V. After that the operating frequency is set up by feedback reference voltage.The SOFT START circuit charges current into TIME CAPACITOR Cs to make SOFT START time to 0.8 ~ 1 SEC and then drives SOFT START circuit. The SOFT START circuit controls feedback reference voltage by linear operation during this period. As result, it becomes lamp current that flows in the BALLAST SYSTEM so that SOFT START is activated.

There is a function that discharges Cs by UN-UVLO signal when it is below UVLO. If Cs is charged alone, the Vcs voltage has primary function, which becomes exponential function when it is connected to Cs in parallel mode. As result, the SOFT START circuit is a circuit configuration to drive feedback reference voltage Vr proportionally during SOFT START period. The SOFT START continues until Vcs voltage becomes 2V. Also, feedback reference voltage that is proportional to Vcs voltage controls the lamp current. Therefore, the is current in the figure grows in proportional to Vcs voltage, whose maximum current is reached when the Vcs becomes 2V. If DIMMING is started, DIMMING current id makes reference voltage Vr by adding and/or subtracting to/from is current.

Oscillator

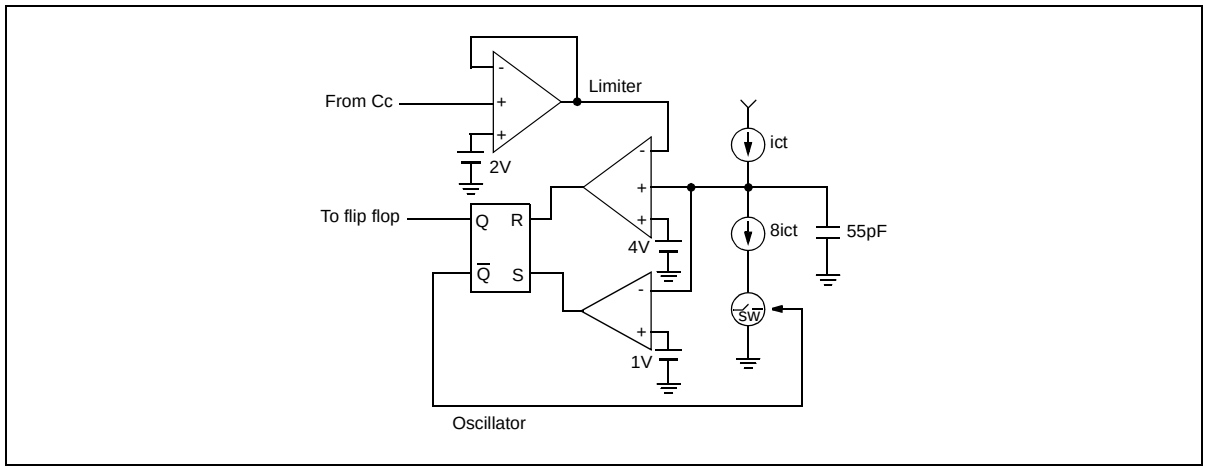
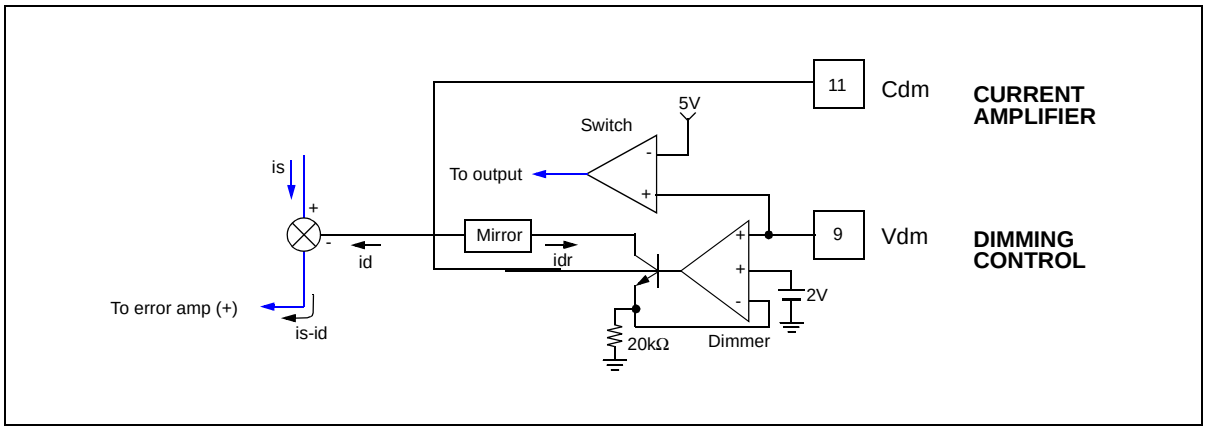


Figure 4. Oscillator

Oscillator block consists of two comparator. The ratio of charging time and discharging time is 7:1. The low comparating reference voltage is set by 1V. Also the high frequency limit is set by 2V and the low frequency limit is set by 4V.

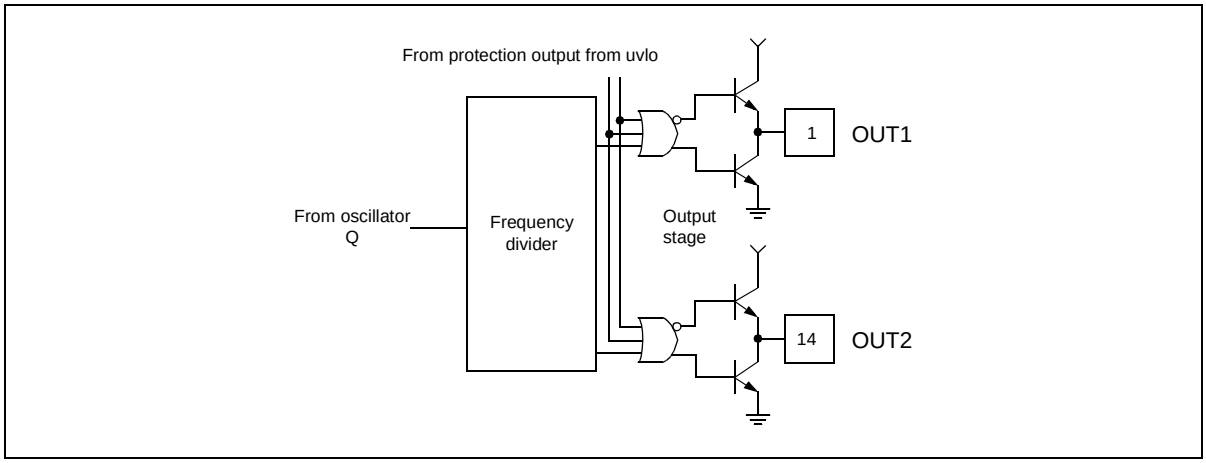
It is a oscillator driven by two comparators and its charge/discharge cycle is 7:1. The characteristics of this circuit is that it generates frequency by specifying LOW comparison potential to 1V and by receiving feedback output as high potential. Also it limits the high potential to minimum of 2V to guarantee maximum frequency and to maximum of 4V to guarantee minimum frequency. The purpose of this operation is to prevent abnormal operation of IC by limiting maximum operation frequency of IC circuit. In addition, the purpose of maximum operation frequency limit is to guarantee ZVS operation in BALLAST SYSTEM operation. ict is FUSING current with guaranteed temperature that guarantees the constant frequency.

Dimming Control Stage



The DIMMING circuit that takes voltage as input has 2V as full dimming. It becomes FULL LIGHTING when the voltage is 0V. The DIMMING START time is when Vcs voltage becomes 4V, and the operation of dimming is determined by DIMMING CAPACITOR Cdm. That is, even if the dimming voltage fluctuates rapidly, the dimming point moves as long as the Cdm charge/discharge time when it takes longer.Switch can toggle output to On/Off through Dimming Input. The advantage of this function is that you can use one dimming end to do Dimming and On/Off.

Output Drive Stage

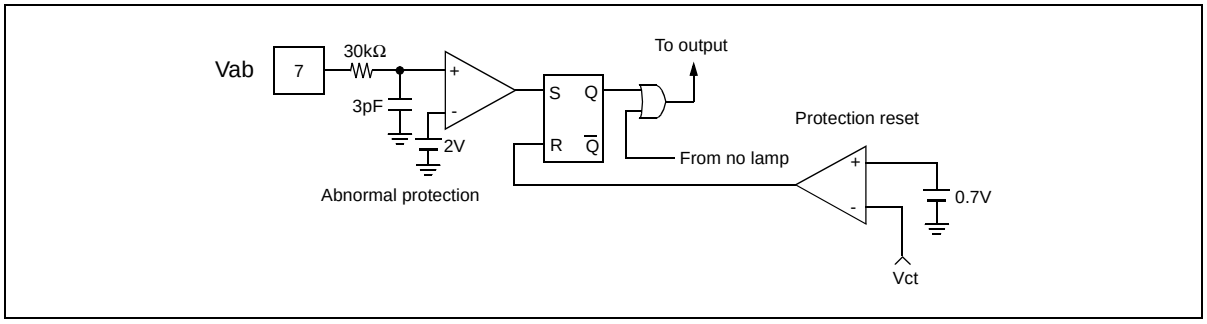


It uses TRANSFORMER to drive high/low side switch of HALF BRIDGE that is a BALLAST SYSTEM. Out 1 and Out2 drive this transformer. Therefore, COIL INDUCTOR is connected to these Out1 and Out2. Out 1 and Out2 have dead time during clock cycle of switching frequency. Out1 and Out2 does not output high signal at the same time. The frequency driver divides Q signal of OSCILLATOR into two to supply Out1 and Out2. Out1 and Out2 control UVLO signal to be maintained low when it is under UVLO. The OUTPUT STAGE has TOTEMPOL structure.

No Lamp Protection

NO LAMP PROTECTION circuit is adopted as direct detection mode and drives switch for NO LAMP to prevent the system from damage.

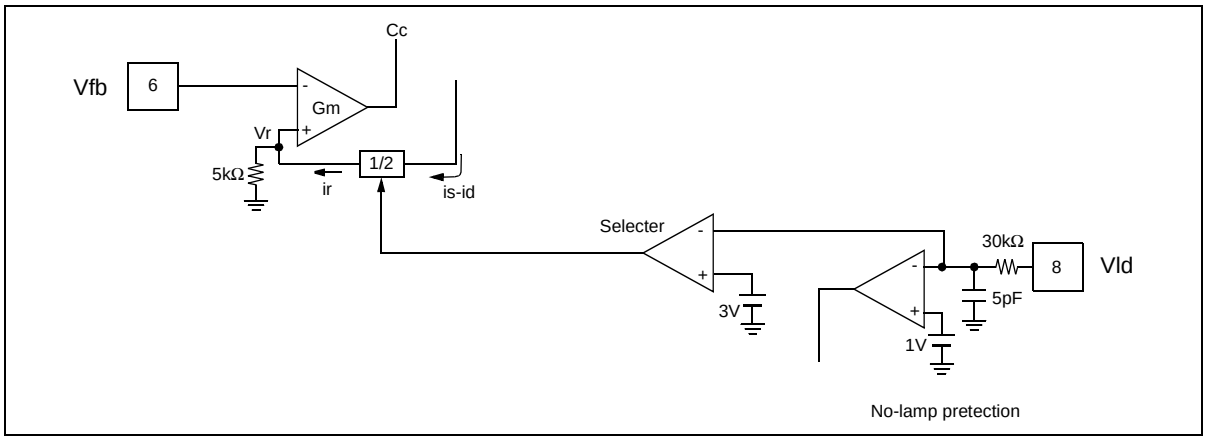
Abnormal Protection



The application part of ABNORMAL PROTECTION is similar to the over current protection, but it is a protection circuit that detects abnormal connection of lamp. Detection voltage is 2V.

ABNORMAL PROTECTION circuit drives LATCH circuit to make output end LOW. Since this latch circuit is reset when Vct is lower than 0.7V, Vcc should restart this circuit.

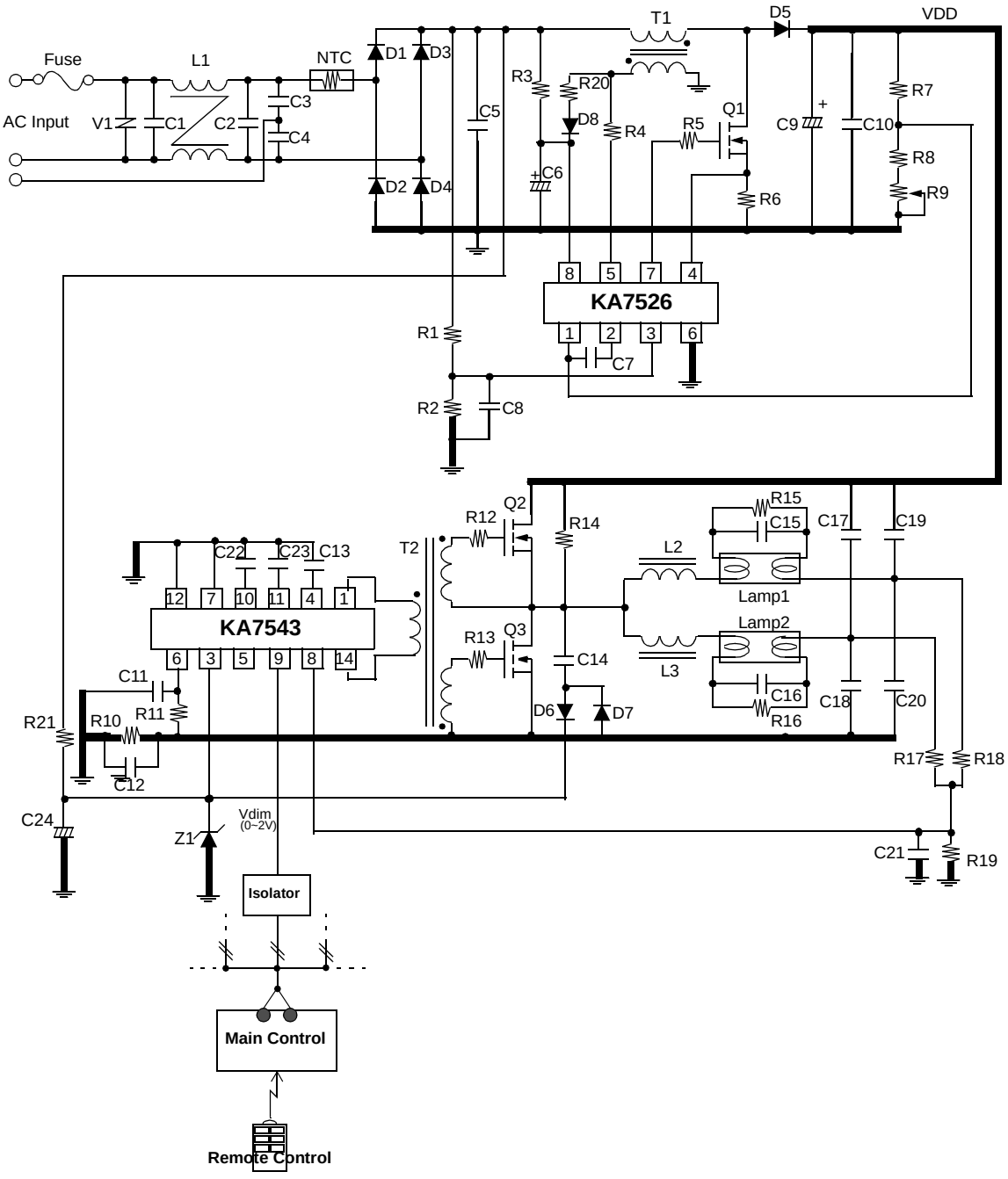
Lamp Selector Stage



LAMP SELECTER performs function for feedback of two lamps and one lamp. Since two lamps stops 1/2 driver and 1/2 driver operates only in one lamp, it adjust ir current that sets feedback reference voltage. The comparison reference voltage of two lamps and one lamp is 3V.

Application Circuit

<85 ~ 265V_{AC} Input, 400V_{DC}, Flourescent Lamps Ballast(32W*2 / 36W*2 / 40W*2>



Components List (32w*2Lamp Application)

Reference	Value	Part number	Manufacturer
R1	2.2MΩ–F, 1/4W	-	-
R2,4,11	22kΩ–F, 1/4W	-	-
R3,21	150kW-J, 1/2W	-	-
R5, 12, 13	47Ω–J, 1/4W	-	-
R6	1Ω–J, 1W	-	-
R7	1.2MΩ–F, 1/4W	-	-
R8	7kΩ–F, 1/4W	-	-
R9	1kΩ Variable Resistor	-	-
R10	6.2Ω–J, 1W	-	-
R14	180kΩ–J, 1/4W	-	-
R15, R16	330kΩ–J, 1/4W	-	-
R17, R18	680kΩ–J, 1/4W	-	-
R19	8.2kΩ–J, 1/4W	-	-
R20	3.3Ω–J, 1/4W	-	-
C1, 2	0.15µF, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1µF, 630V	Miller-CAP	-
C6,24	47µF, 35V	Electrolytic	-
C7	0.33µF, 25V	Ceramic	-
C8	0.01µF, 25V	Ceramic	-
C9	47µF, 450V	Electrolytic	-
C10	0.22µF, 630V	Miller-CAP	-
C11,12,13	0.1µF, 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	0.1µF, 25V	Ceramic	-
C22	4.7µF, 35V	Electrolytic	-
C23	22µF, 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	2.2MΩ–F, 1/4W	-	-
R2,4,11	22kΩ–F, 1/4W	-	-
R3	150kΩ–J, 1/2W	-	-
R5, 12, 13	47Ω–J, 1/4W	-	-
R6	1Ω–J, 1W	-	-
R7	1.2MΩ–F, 1/4W	-	-
R8	7kΩ–F, 1/4W	-	-
R9	1kΩ Variable Resistor	-	-
R10	5.8Ω–J, 1W	-	-
R14	180kΩ–J, 1/4W	-	-
R15, R16	330kΩ–J, 1/4W	-	-
R17, R18	680kΩ–J, 1/4W	-	-
R19	8.2kΩ–J, 1/4W	-	-
R20	3.3Ω–J, 1/4W	-	-
C1, 2	0.15μF, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1μF, 630V	Miller-CAP	-
C6,24	47μF, 35V	Electrolytic	-
C7	0.33μF, 25V	Ceramic	-
C8	0.01μF, 25V	Ceramic	-
C9	47μF, 450V	Electrolytic	-
C10	0.22μF, 630V	Miller-CAP	-
C11,12,13	0.1μF, 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	0.1μF, 25V	Ceramic	-
C22	4.7μF, 35V	Electrolytic	-
C23	22μF, 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	2.2MΩ–F, 1/4W	-	-
R2,4,11	22kΩ–F, 1/4W	-	-
R3,21	150kΩ–J, 1/2W	-	-
R5, 12, 13	47Ω–J, 1/4W	-	-
R6	1Ω–J, 1W	-	-
R7	1.2MΩ–F, 1/4W	-	-
R8	7kΩ–F, 1/4W	-	-
R9	1kΩ Variable Resistor	-	-
R10	5.6Ω–J, 1W	-	-
R14	180kΩ–J, 1/4W	-	-
R15, R16	330kΩ–J, 1/4W	-	-
R17, R18	680kΩ–J, 1/4W	-	-
R19	8.2kΩ–J, 1/4W	-	-
R20	3.3Ω–J, 1/4W	-	-
C1, 2	0.15μF, 630V	MEP-CAP	-
C3, 4	2200pF, 3000V	Y-CAP	-
C5	0.1μF, 630V	Miller-CAP	-
C6,24	47μF, 35V	Electrolytic	-
C7	0.33μF, 25V	Ceramic	-
C8	0.01μF, 25V	Ceramic	-
C9	47μF, 450V	Electrolytic	-
C10	0.22μF, 630V	Miller-CAP	-
C11,12,13	0.1μF, 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	0.1μF, 25V	Ceramic	-
C22	4.7μF, 35V	Electrolytic	-
C23	22μF, 35V	Electrolytic	-
D1, 2, 3, 4	1000V, 1A	1N4007	-

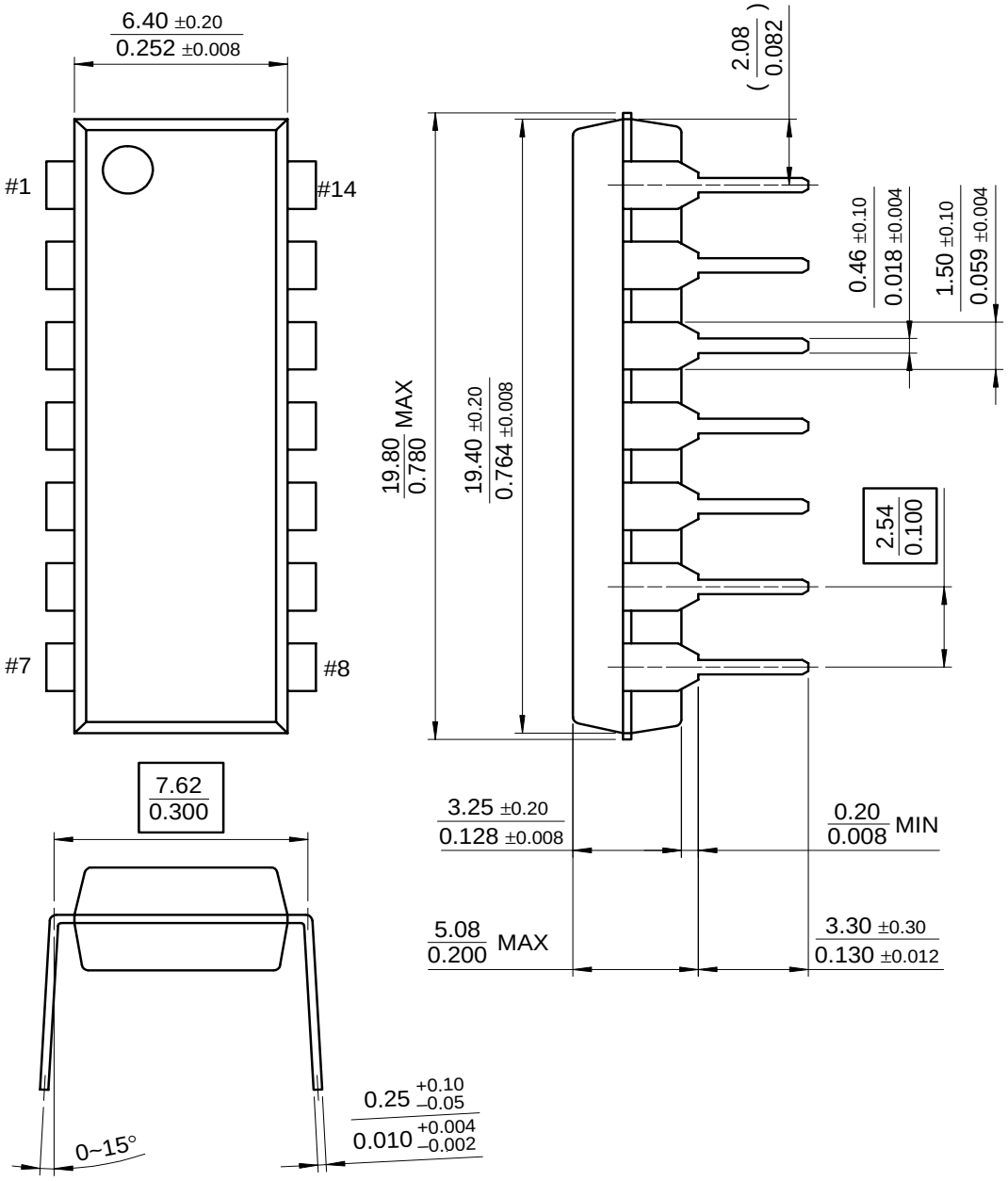
Components List(40w*2Lamp Application) (Continue)

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

Dimensiomn in milimeters

Package

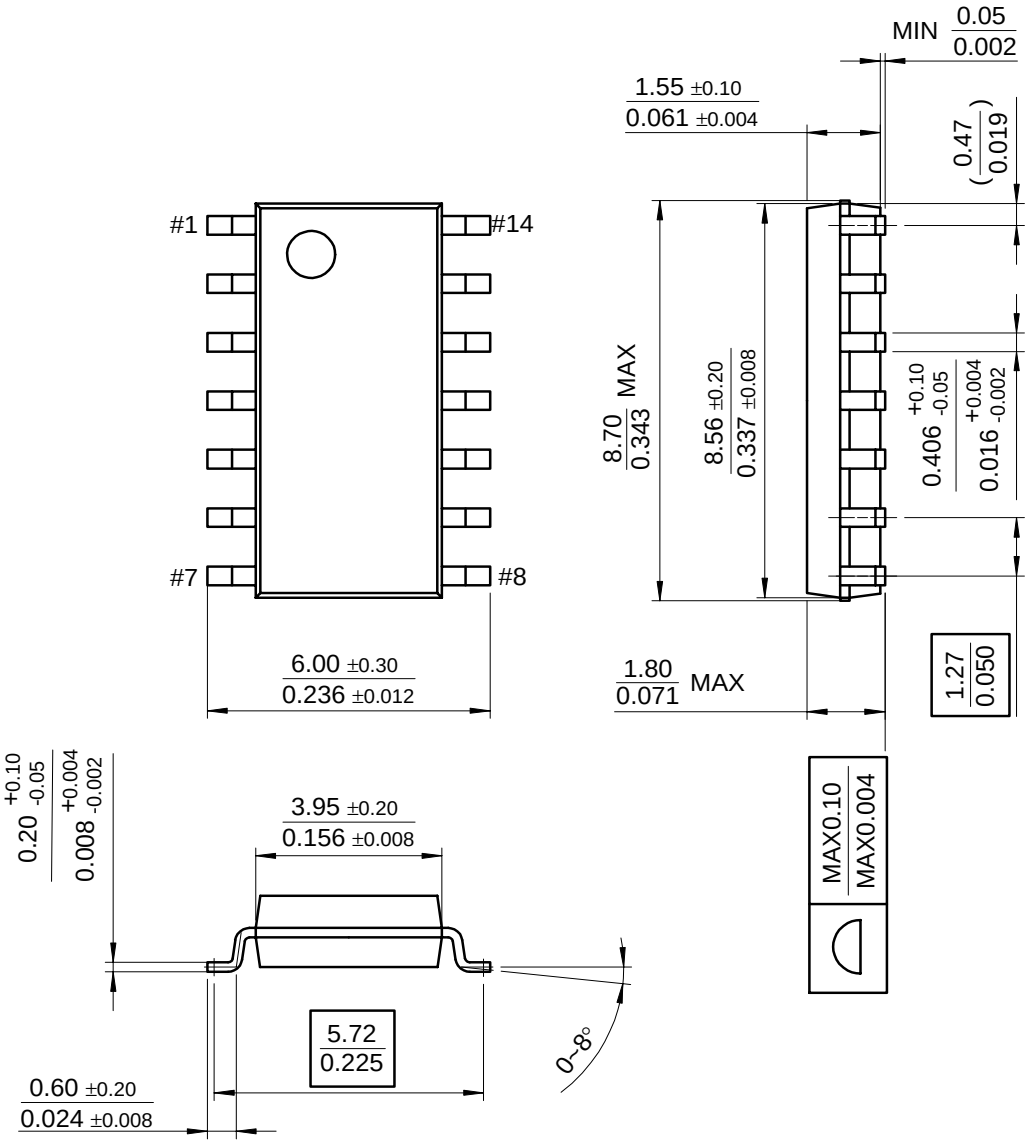
14-DIP



Dimensions in milimeters (Continued)

Package

14-SOP



Ordering Information

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

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