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# AN9006

## IGBT Application Note For Camera Strobe

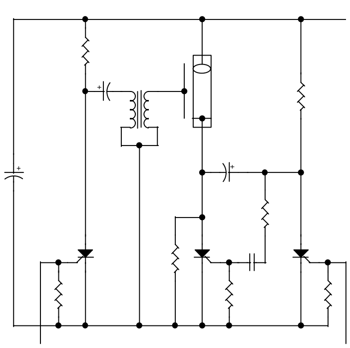
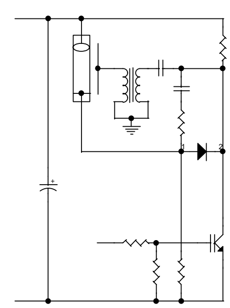
## Camera Strobe System Summary

The Camera Strobe System (Portable & DSC) is a lighting system for taking pictures in relatively dark areas, without the accompanying negative effect on picture quality. The strobe system is becoming smaller, lighter and easier to control, increasing the popularity of DSC and portable automatic cameras.

## 1) Strobe System Control Methods

The control methods are largely divided into two groups: One uses SCR, and the other uses IGBT. The advantages and disadvantages of both methods are compared below:

**Table 1: Comparison of Control Methods**

| Item | SCR Control | IGBT Control | Remarks |
|---|---|---|---|
| Circuit Configuration | • Complicated  | • Simple (Can be directly operated from Logic)  | |
| Current Capacity | • Up to hundreds Amp. | • Up to 150A (@ logic level) | |
| Disadvantages | • Low battery efficiency (full electric discharge)<br>• Hard to achieve red eye prevention function<br>• Need SCR for turn-off<br>• Limitation in luminosity control | • High intensity luminosity is difficult. | |
| Advantages | • High intensity luminosity is possible | • Fast response time<br>• Red eye prevention function is possible<br>• High battery Efficiency | |

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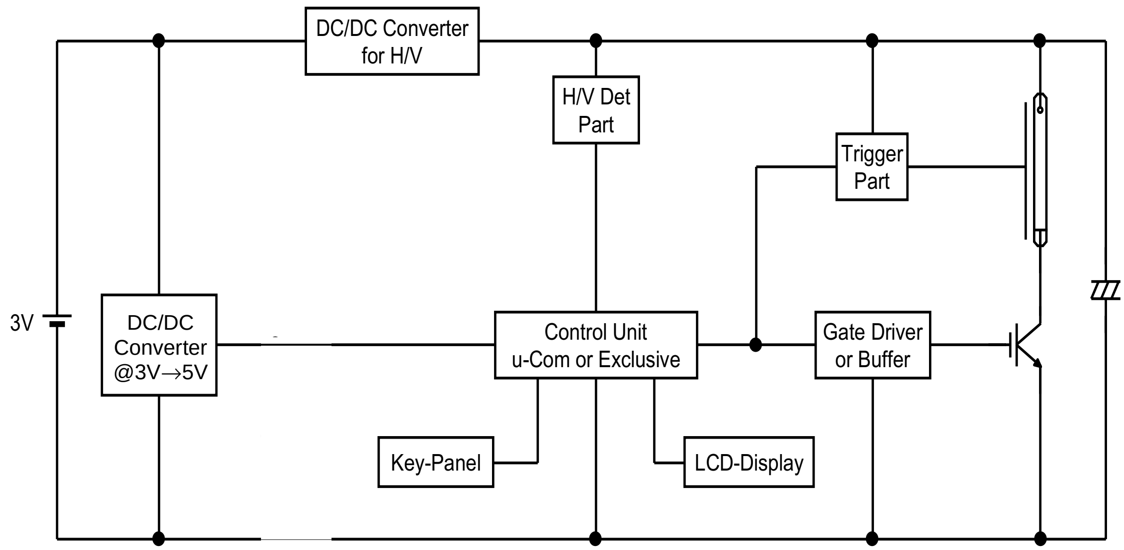
## Figure 1: Camera System Block Diagram




## Figure 2: Strobe System’s Circuit Diagram

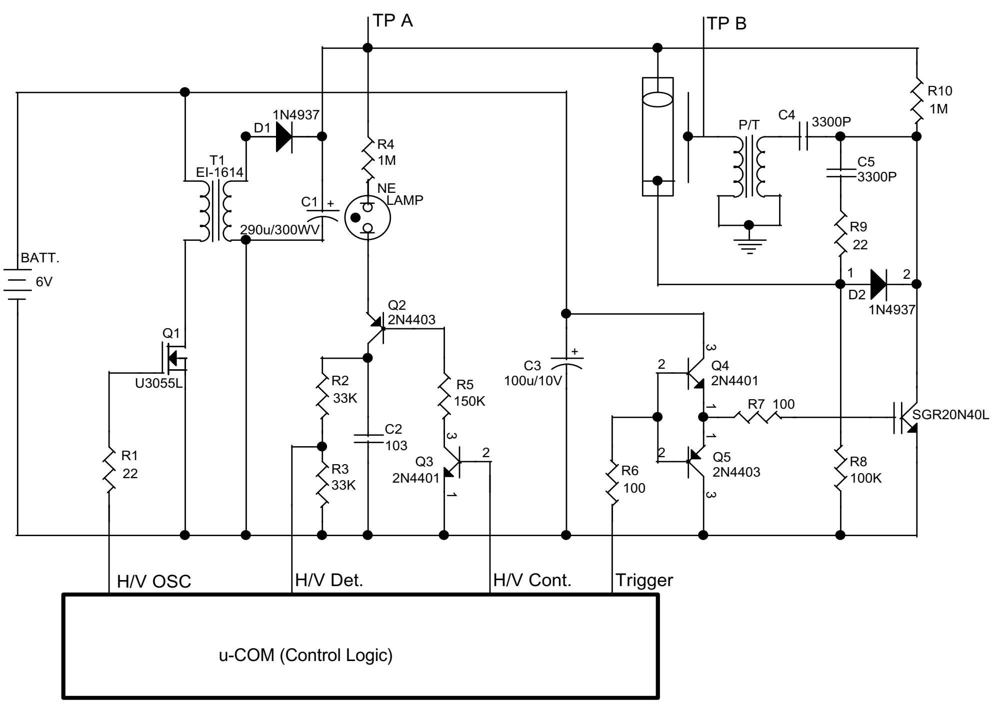
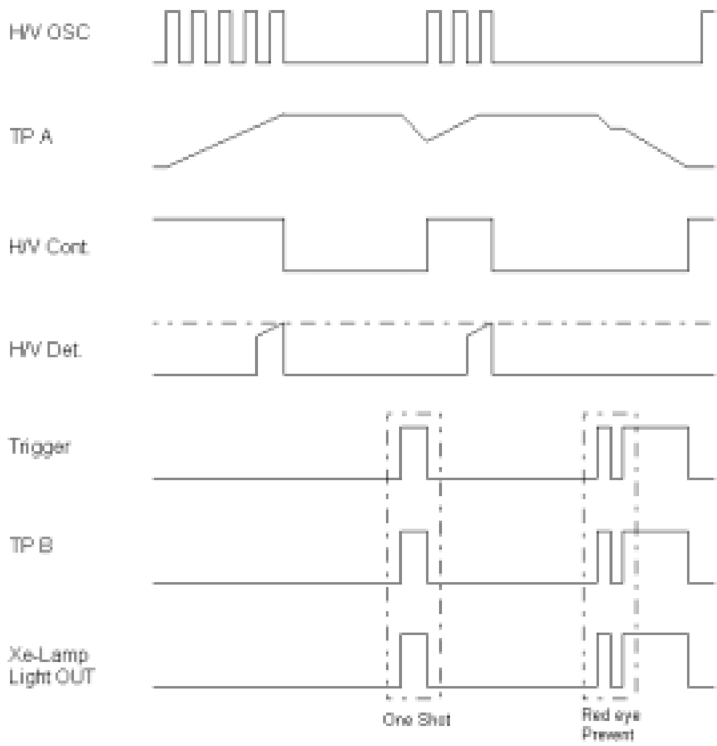


**Figure 3: Timing Chart for Each Block**




*Glossary
H/V OSC: High Voltage Oscillator
TP A : High Voltage Main Capacitor
H/V Det : High Voltage Detection Output
H/V Cont: High Voltage Control Input
Trigger : Trigger Input
TP B : Xe-Lamp Trigger

< Timing Chart for Each Block>

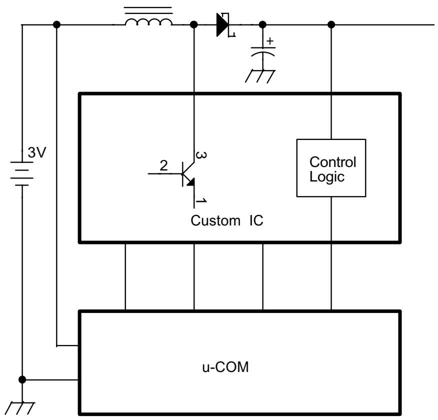
## 2) Control Power Block Configuration

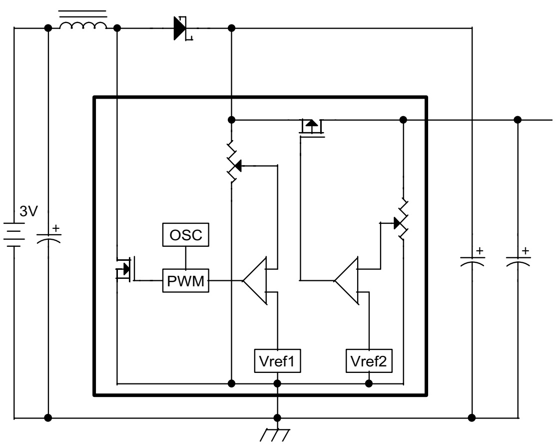
Portable cameras and DSC use 3 V or 6 V batteries, but lately the 3 V battery is becoming more prevalent. When using a 3 V power source, the IGBT`s gate drive Voltage is insufficient, even with a logic level IGBT. Hence, a boost-up circuit is reequired for DC power voltage. The boost-up circuit, used in a portable strobe system, is divided into two types.

1. Boost-up circuit using u-COM
   The circuit has the PWM Controller function built-in within the u-COM for system control, and produces about 100-150 Khz of S/W frequency for reducing transformer size. Duty control functionality is also available.

2. Boost-up circuit using a DC/DC Converter
   This is the most commonly used circuit. It is used independently without the control of a u-COM. The converter used, most often, is the RS5RM series type with RICOH`s PWM and built in voltage detection . This circuit mainly boosts 3 V power up to 5 V. It has a switching frequency of 50 Khz, and the duty is variable up to a maximum of 90%. When the output voltage is lower than a specific value, it is compensated for by increasing the duty. When it is higher than a set value, it saves energy in the coil while the internal TR is on. When the TR is turned off, the 3 V power voltage and organic voltage are combined to provide 5 V output.

**Figure 4: (a) Boost-up Circuit using u-COM** **(b) Boost-up Circuit using a DC/DC Converter**




## 3). Fairchild Strobe IGBT Demo System

**Figure 5: System Circuit**

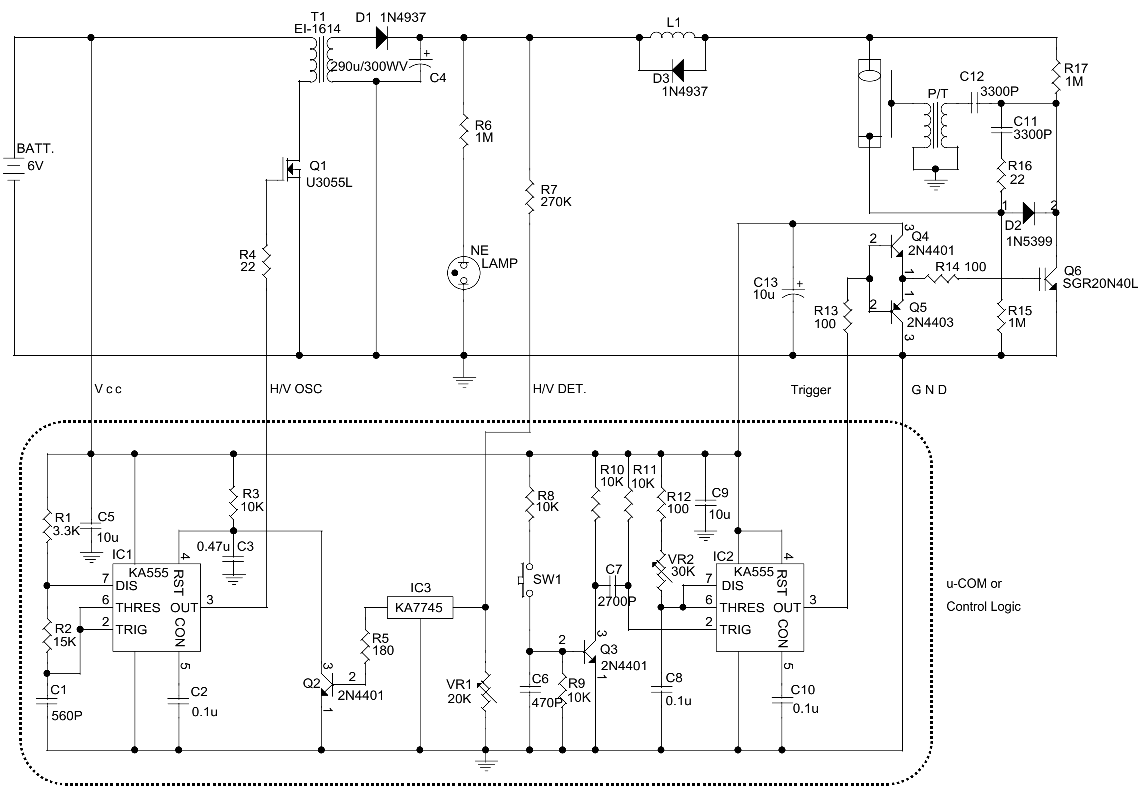



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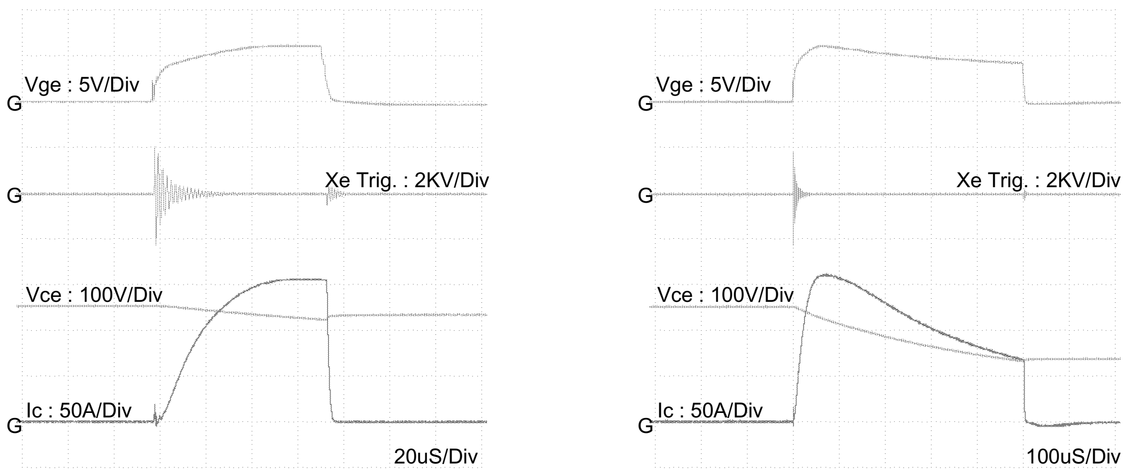
**Figure 6: Strobe System Function Waveforms**



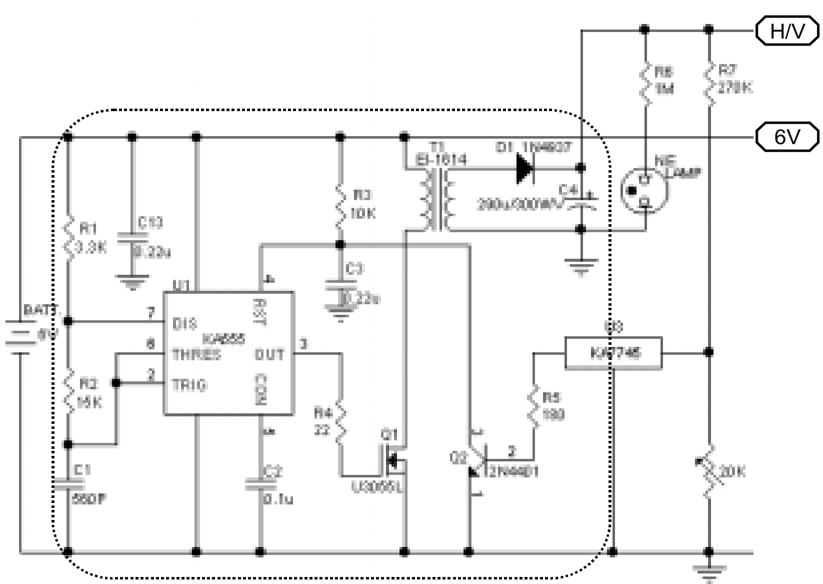

< Short Period >     < Long Period >

## 4) System Block Explanation

### 1. DC/DC Converter Block

The DC/DC Converter Block takes the 6 V power and produces the HV needed for lamp lumination. It functions as a 100 Khz Forward Type Switching Regulator using a KA555.

**Figure 7: DC/DC Converter Block**

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The switching frequency and duty are set by the resistance (R1) between KA555`s $V_{CC}$ and Pin 7, the resistance (R2) at connecting pins 7, 6 and 2, and the capacitor (C1) value.
f = 100 Khz (@ T = 10 µS)
Ton = 4.5 µS, Toff = 5.5 µS
Toff = 0.67 * R2 * C1 (Here, C1 = 560 pF)
Rb = Toff / (0.67 * C1)
= 5.5 µS / (0.67 * 560 pF) = 14658Ω (here the standard resistance is 15 kΩ)
Ton = 0.67 * (R1+R2) * C1
Duty = R2 / (R1+2R2) = 0.45
= 15kΩ / (R1+ (2 * 15 kΩ)
R1 = 3.3 kΩ
KA555’s pin 4 (Reset) receives a signal detected in Block 2’s HV, and is able to stop KA555. The Reset block (4) changes to Reset mode between 0.4 and 1.0 V (Min/Max), so you must be careful with the voltage level.

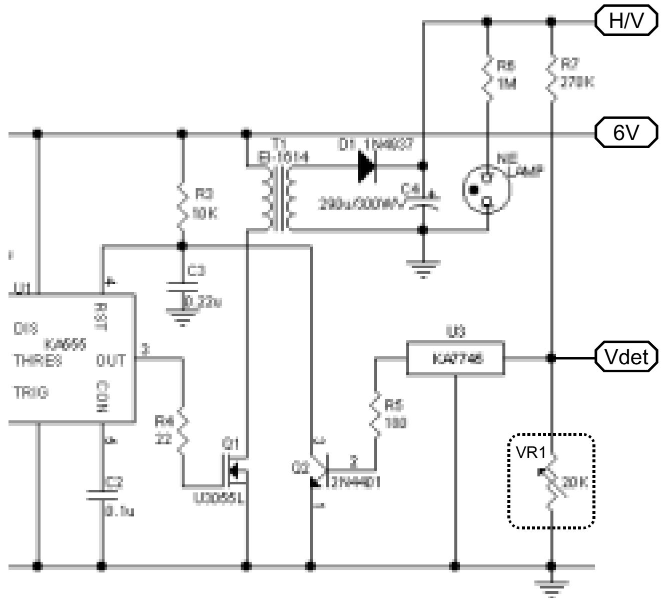
**2. Design of the Boosting Transformer**

The transformer`s size is EI-1614. A smaller size is better for making the product smaller and lighter. In this design the most commonly available smallest size is used.


First calculate the 1st order coil Np.
Then calculate the 2nd order coil Ns.
Np = (Vin * ton / B * Ae) * 108
= (6V * 4.5uS / 2200G * 0.1982) * 108
= 6.19 T (approximately 6T)
(The battery’s voltage failure and a discharge of up to 5.2 V are factored into the design)
Ns = (Vs * Np) / Vin(min)
= (300V * 6T) / 5.2V = 346.15T (approximately 346T)

## 3. H/V Detection Block

**Figure 8: H/V Detection Block**

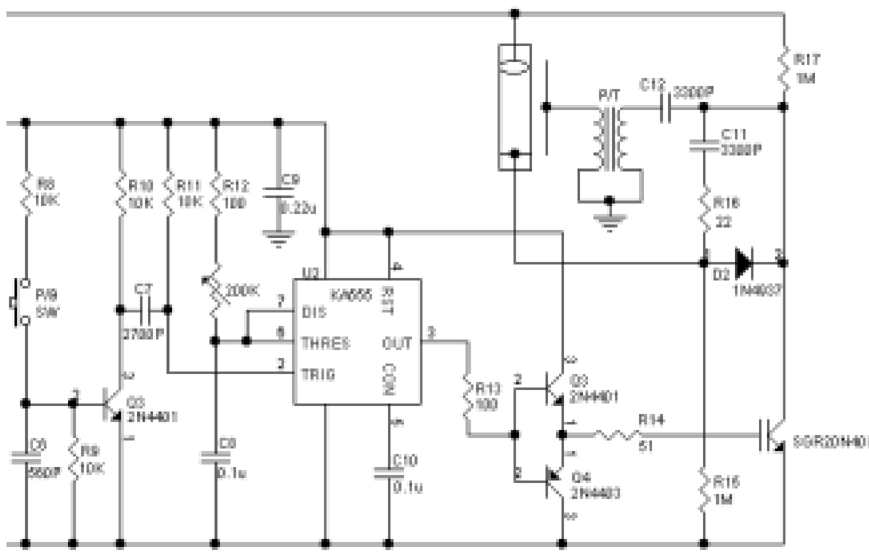



This block detects voltages from 250 to 300 V and controls Block 1. It uses the component KA7745 for voltage detection(detection volt: 4.5 V).

When Vdet. block`s voltage is below 4.5 V, the KA7745`s output is low, and when it is over 4.5 the output is high. The high output activates Q2, lowers KA555`s pin 4`s level, and stops the DC/DC converter by putting it in a Reset Condition. The voltage is detected by dividing HV using resistance, and HV is set to the required value (200-300 V) using VR1. The NE-lamp shows the condition of the energy stored in the capacitor.

4. **Strobe Light Duration Control Block for Lighting Duration**
This block outputs a trigger signal using the Time IC KA555, activating it to mono-stable mode, and by receiving an external trigger signal. The output pulse (duration of luminescence) is adjusted using the Rt and Ct connected to pins 6 and 7 on the KA555.

**Figure 9: Strobe Light Duration Control Block for Lighting Duration**

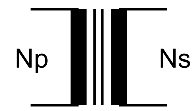



In mono-stable mode, T = 1.1 * Rt * Ct. Hence, the Xenon-lamp's luminescence duration is maintained between the following:
T(min) = 1.1 * 100Ω * 0.1µF = 11µs
T(max) = 1.1 * 200.1kΩ * 0.1µF = 22ms
The KA555 has a source/sink capability of upto 200 mA, and directly activates the IGBT (SGR20N40L). But in this system a Buffer Block is added using TR just in case there is a shortage of gate drive capability.
- SGR15N40L and SGR20N40L are logic level IGBTs, and can be operated directly from many different types of logic ICs, as long as the control logic part`s output current is above 100 mA.

5. **Strobe Unit**

This unit is composed of the Xenon lamp and the trigger transformer. The trigger pulse ionizes the gas mixture within the Xenon lamp. It also receives a signal (about 250-300 V) when the S/W element IGBT is on, and produces an HV trigger signal of about 4 to 5 kV by using the pulse transformer's turn number and ratio. The pulse transformer can be designed as follows.

$$V(trig) = \frac{N2}{N1} \times Vin$$




The Vin is about 250 to 300 V, and the voltage is determined by the turn ratio. If the trigger pulse voltage is low, the Xenon lamp does not luminate or does so irregularly. If it is too high, the Xenon lamp's electrode may discharge or damage other parts nearby. The trigger pulse output wire should be as close as possible to the Xenon lamp trigger's electrode.

## 5). Notes for Constructing a Strobe System

- The energy capacity of a small strobe lamp is below 20 W-S, and it should not be exceeded. (refer to the of the Xenon tube specifications)
- The P/T (trigger transformer) should be designed for an output of about 4 to 5 kV. If it is too low, the Xenon lamp does not luminate or does so irregularly . If it is too high, the Xenon lamp's electrode discharges and may damage neighboring parts.
- The wire between the energy storing capacitor and the Xenon lamp should be as short and thick as possible.

## Comparison of Fairchild Strobe IGBTs with Competitors'

**Table 2: FAIRCHILD Strobe IGBT Line-up & Competitor**

| Gate Drive Volt. [V] | Rating | | FAIRCHILD | Mitsubishi | Toshiba | Remark |
|---|---|---|---|---|---|---|
| | V | A | | | | |
| 4.5 | 400 | 130 | SGR15N40L | CT20ASJ-8 | GT5G103 | D-PAK |
| | | | SGU15N40L | | | I-PAK |
| | | 150 | SGR20N40L | CT25ASJ-8 | GT8G103 | D-PAK |
| | | | SGU20N40L | | GT8G121 | I-PAK |

## Package Dimensions

**Figure 10: D-PAK**

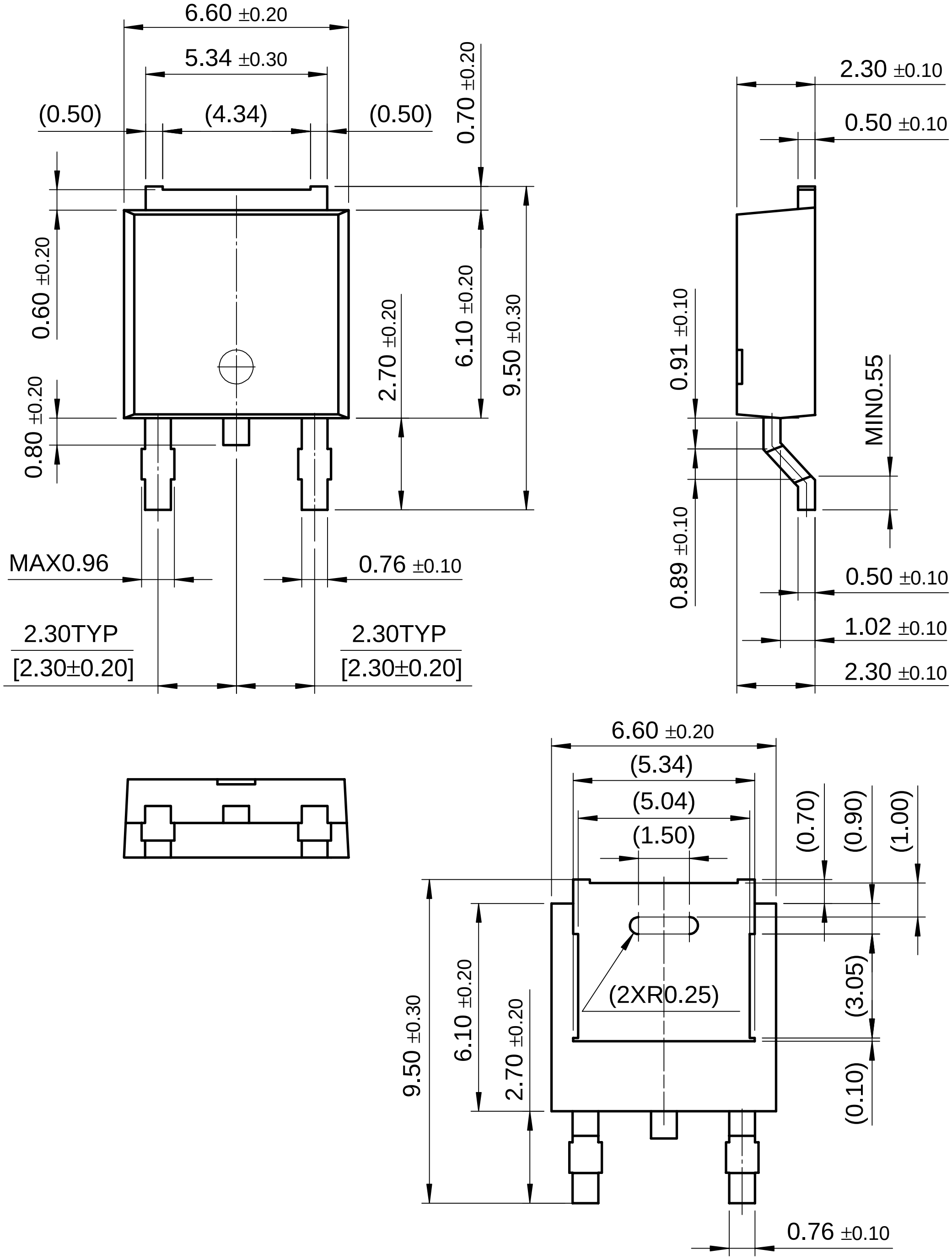



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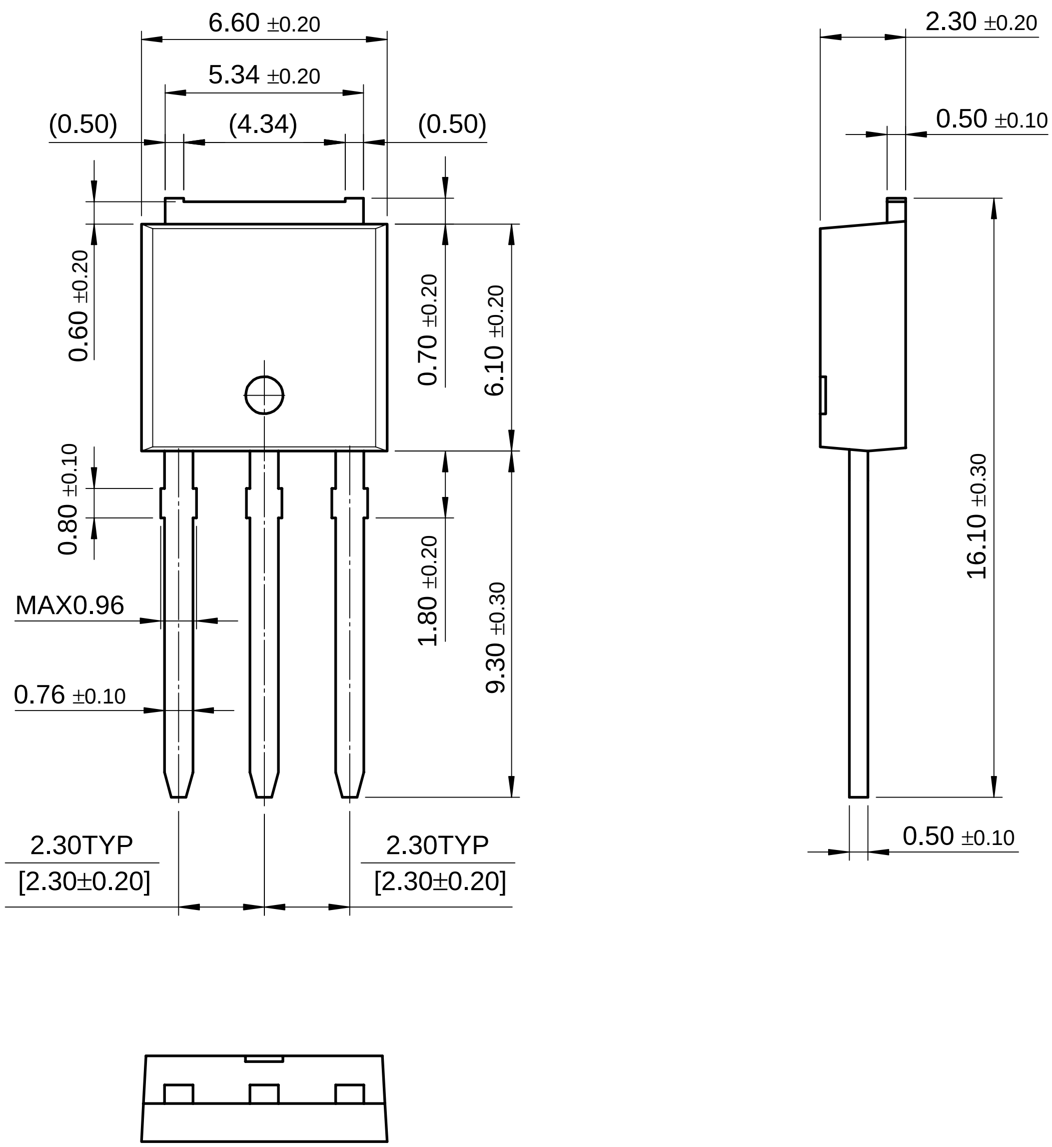
**Figure 11: I-PAK**



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