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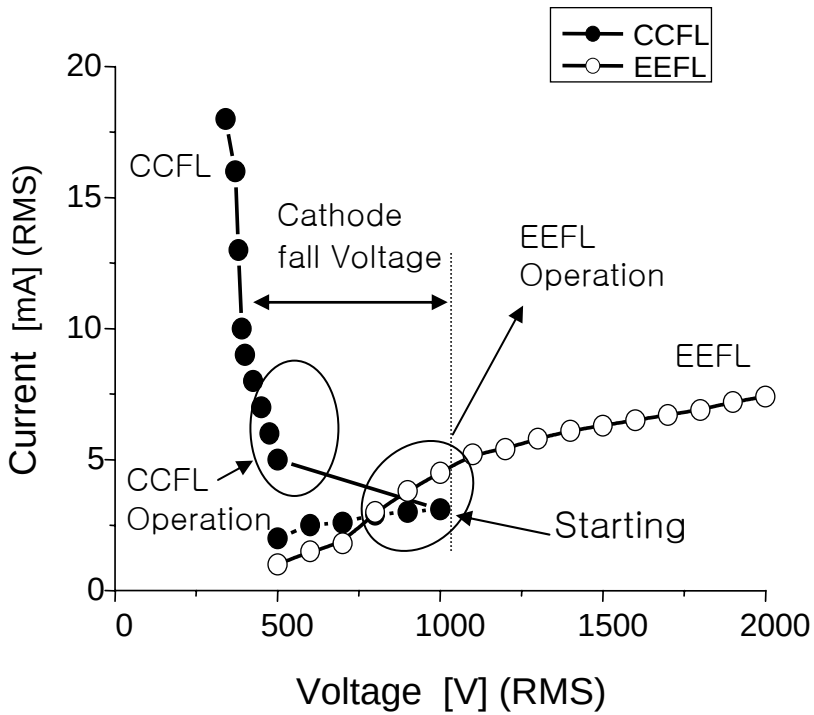
EEFL-Backlight Technology

(End-Cap Type External Electrode Fluorescent Lamp)

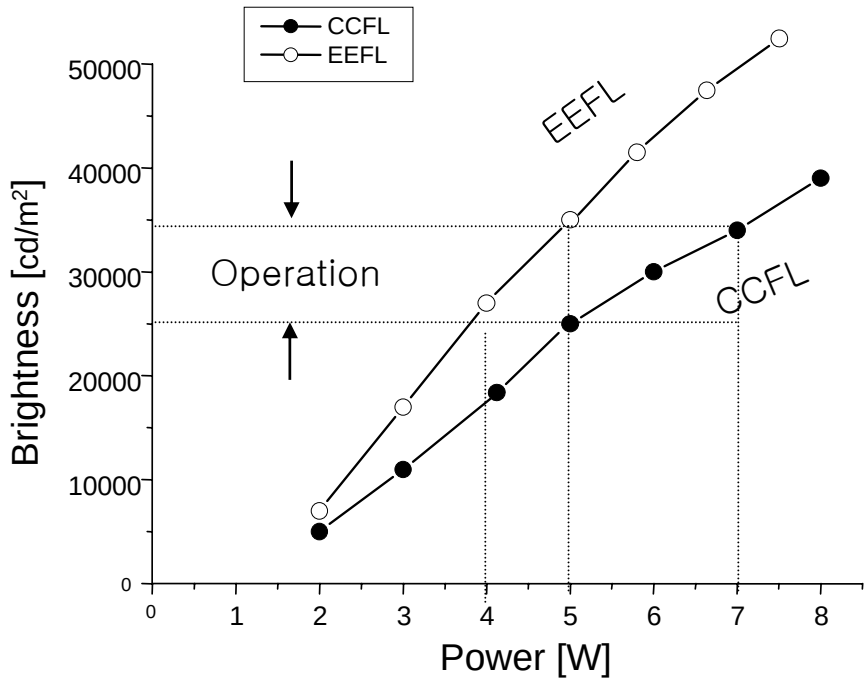
KDT m&s Co.,Ltd., Korea

Basic Characteristics of CCFL & EEFL

I-V Characteristics

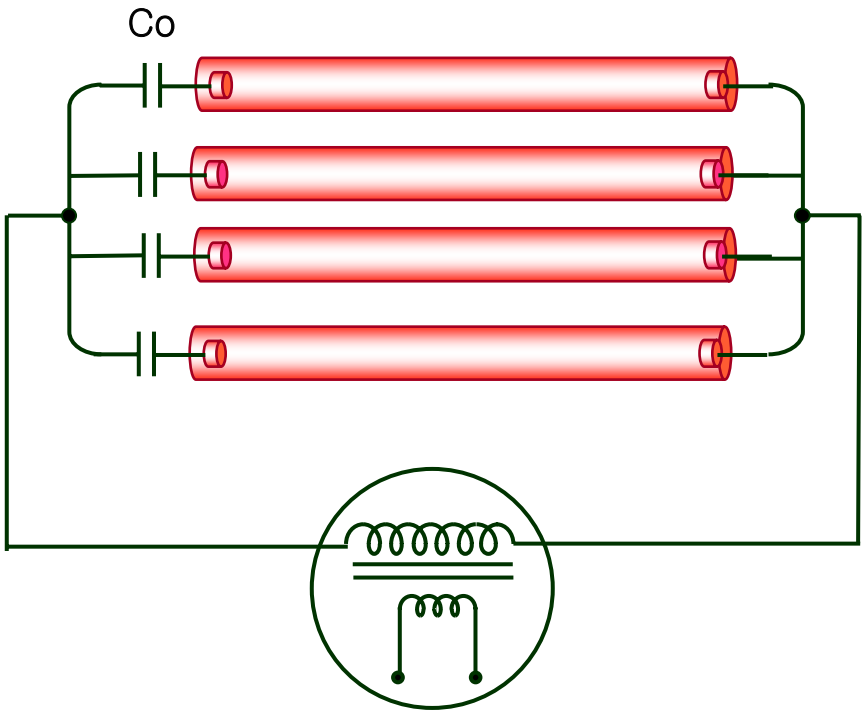


19″ Lamp(2.6 mm / 393 mm)



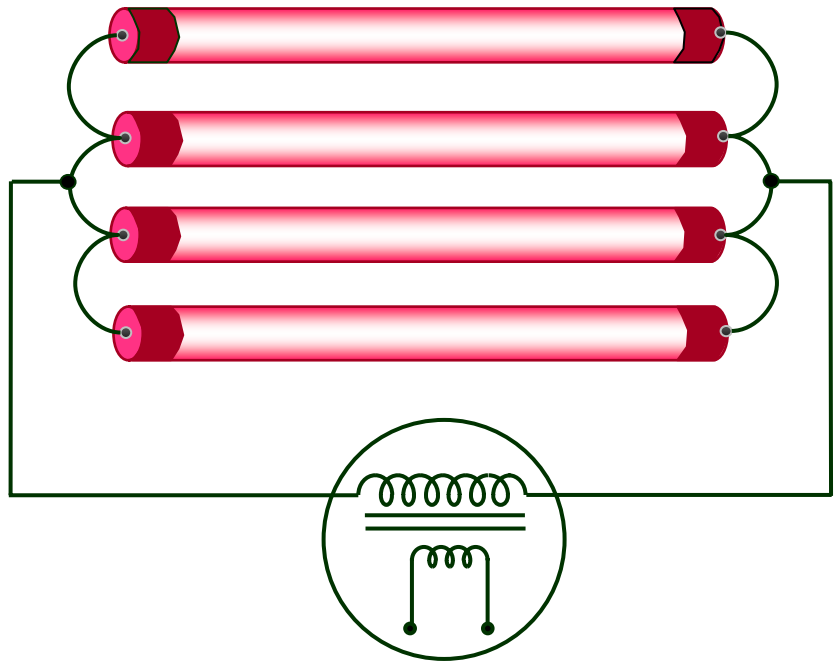
Basic Characteristics

Multi-CCFLs



- Co : Ballast Capacitor for the Uniformity

Multi-EEFLs



- Good Uniformity

- **Key Issues ;**

1st. Switching Inverter generating **AC-Square Pulses**

2nd. Driving Methods of **Self-Discharge Synchronizing**

3rd. New External Electrode Formation Scheme

: **Metal-Glass Melt-Bonding Technology** provides High Capacitance

Lamp Operation

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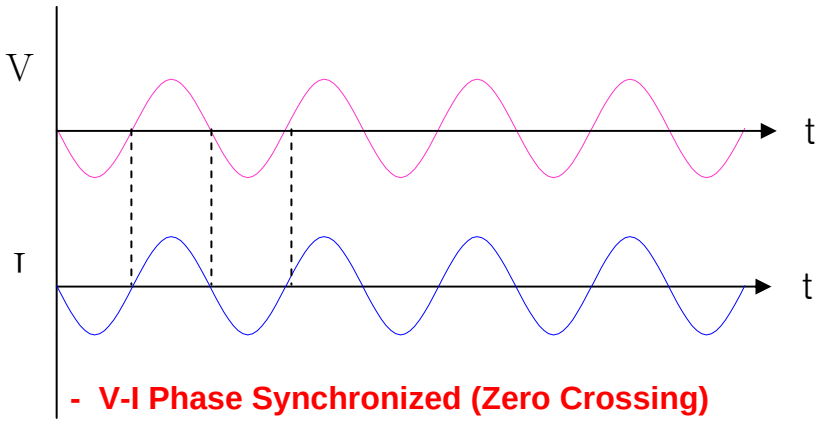
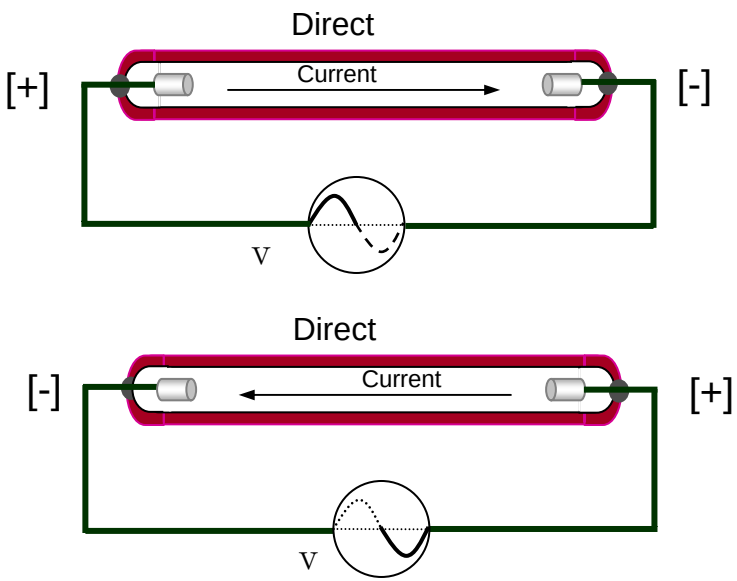
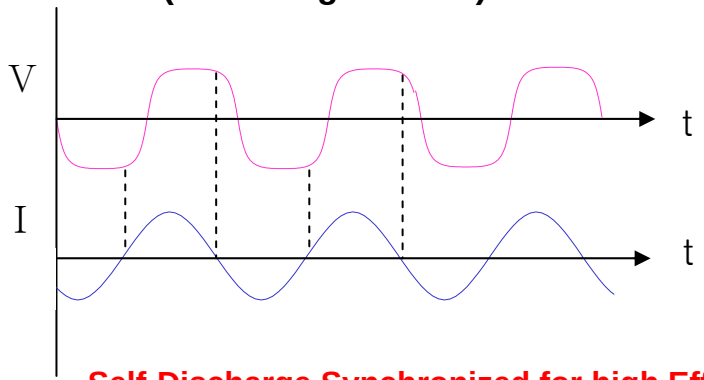
CCFL (LC-Resonance Inverter)



- V-I Phase Synchronized (Zero Crossing)

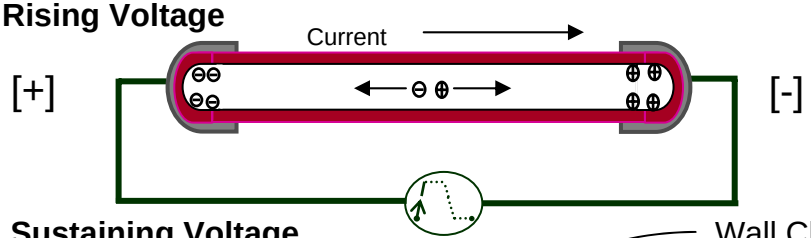


EEFL (Switching Inverter)

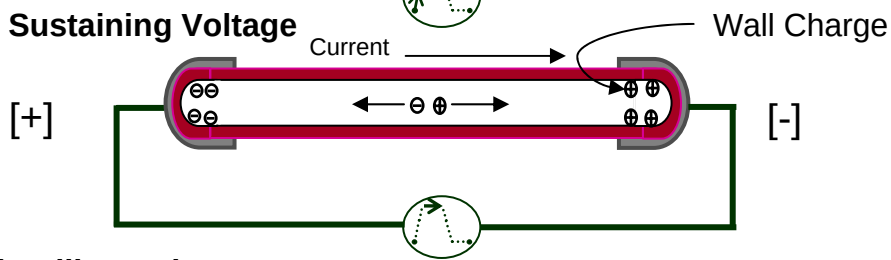


- Self-Discharge Synchronized for high Efficiency

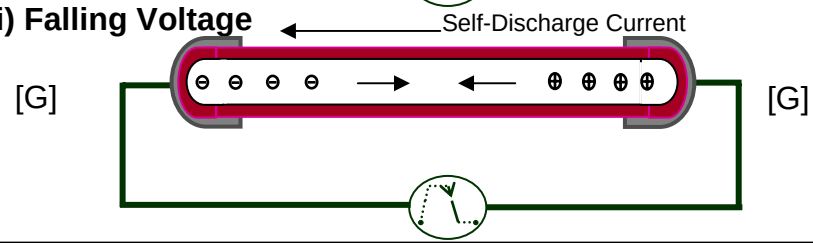
(i) Rising Voltage



(ii) Sustaining Voltage



(iii) Falling Voltage



Switching Inverter

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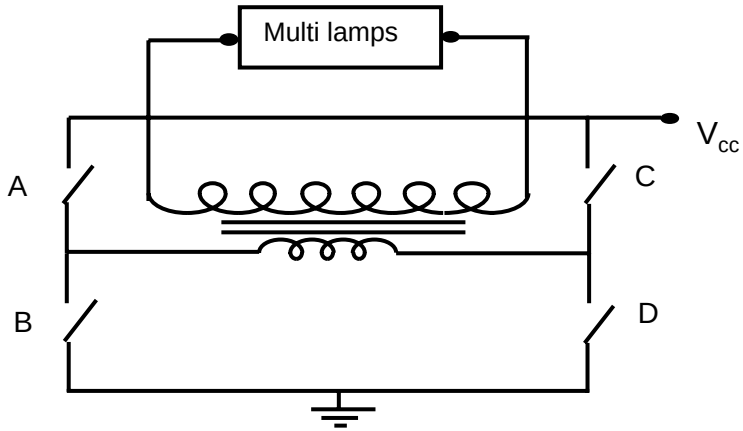
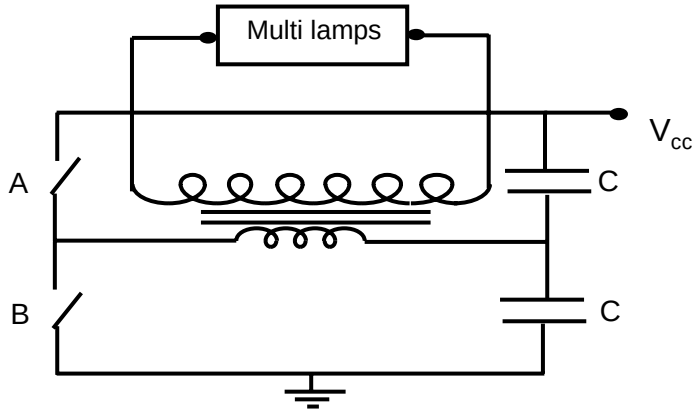
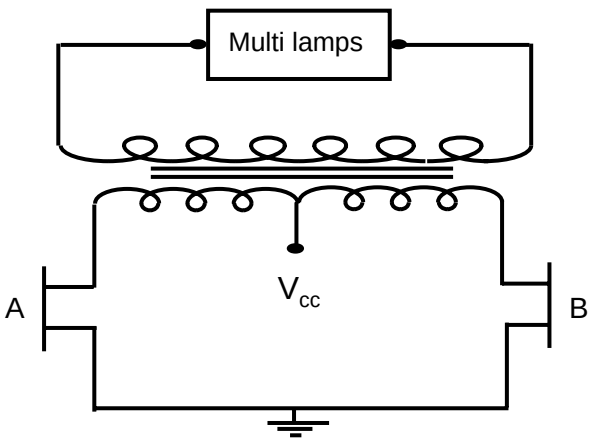
- **Full-Bridge Circuit**



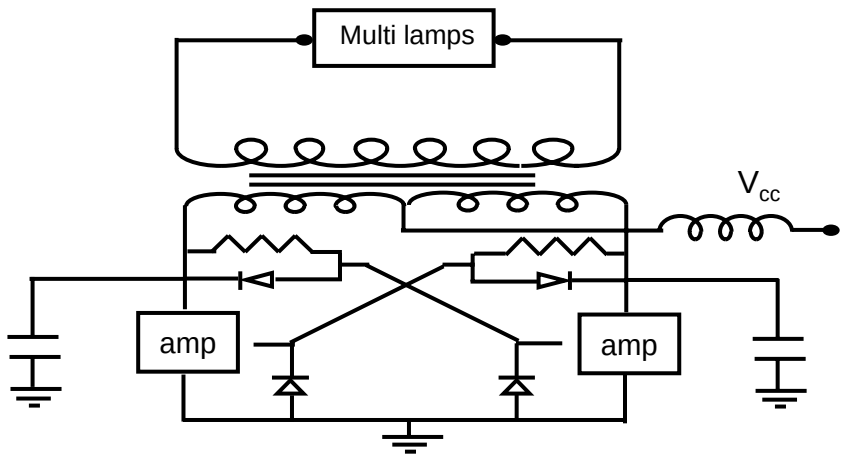
- **Half - Bridge Circuit**



- **Push-Pull Circuit**



- **AStable Multi - Vibrator**



EEFL Driven by a Switching Inverter

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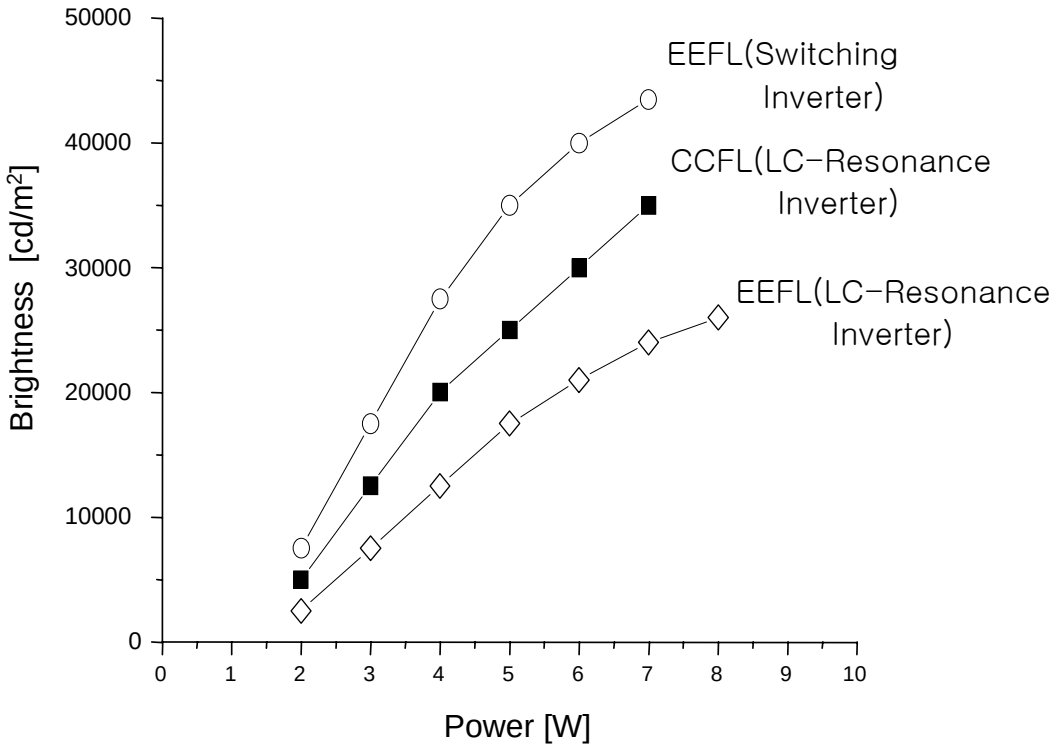
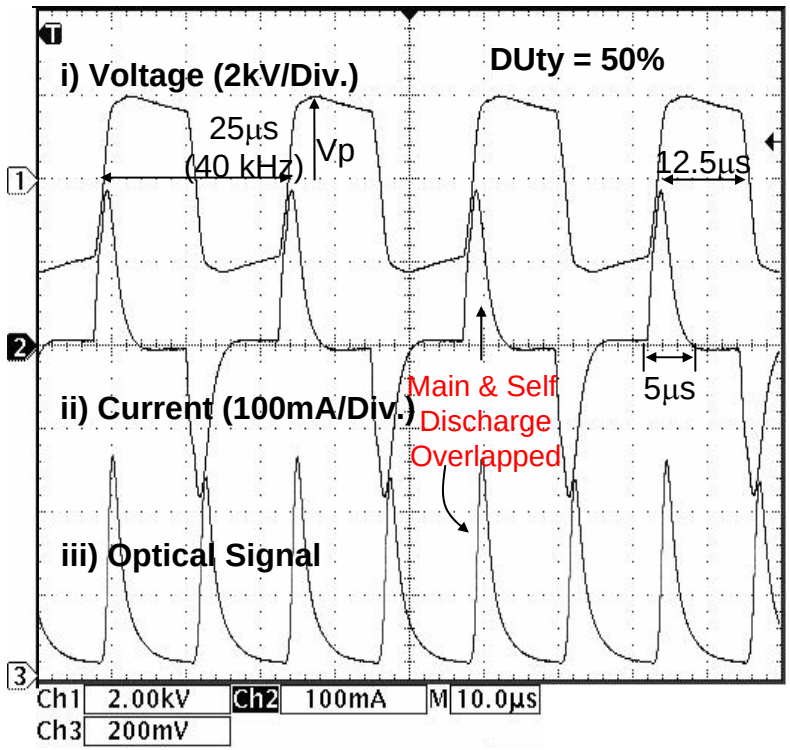
– 19″ Lamp

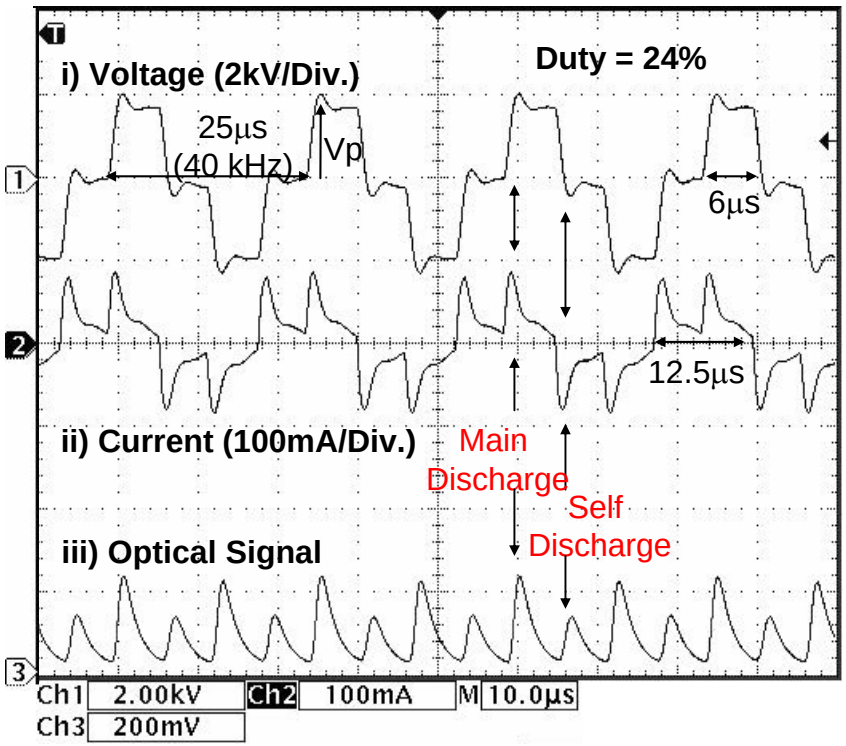


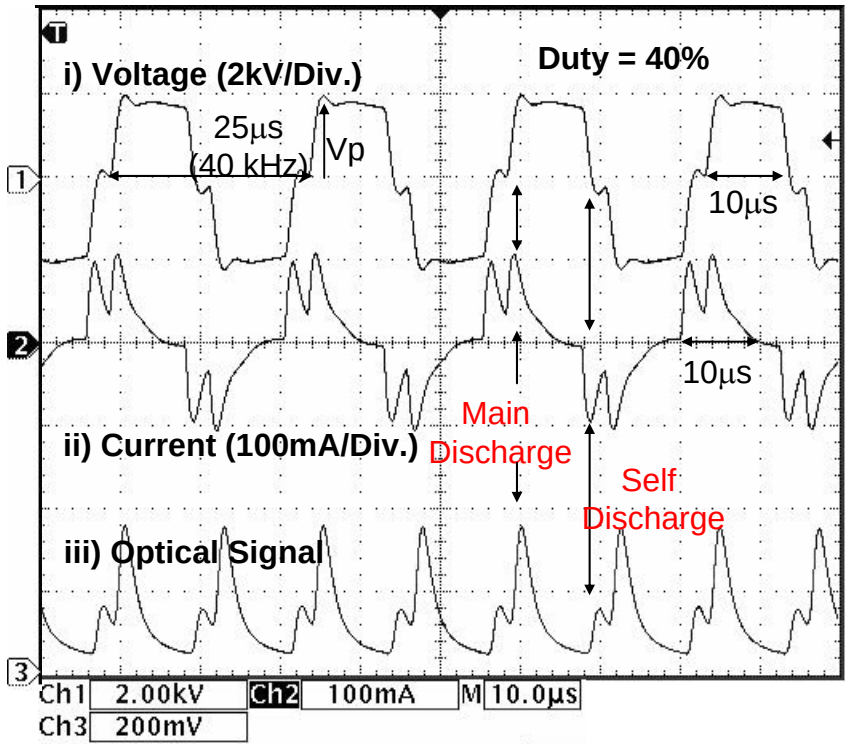
– EEFL(Switching Inverter)



EEFL Driven by a Switching Inverter

Confidential





EEFL Driven by a Switching Inverter

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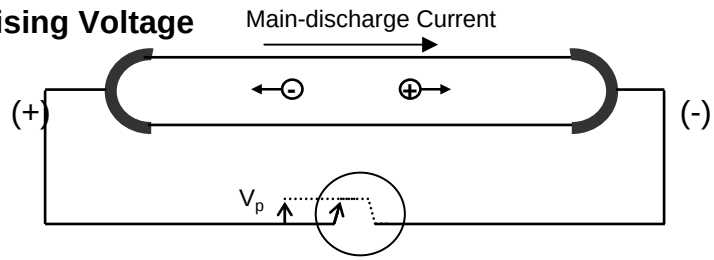
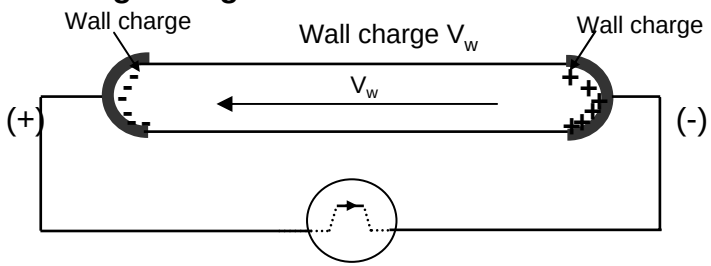
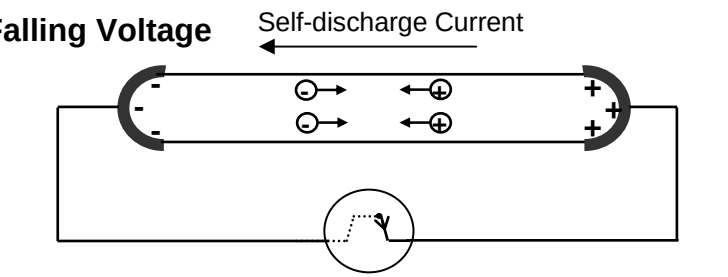
a) Rising Voltage

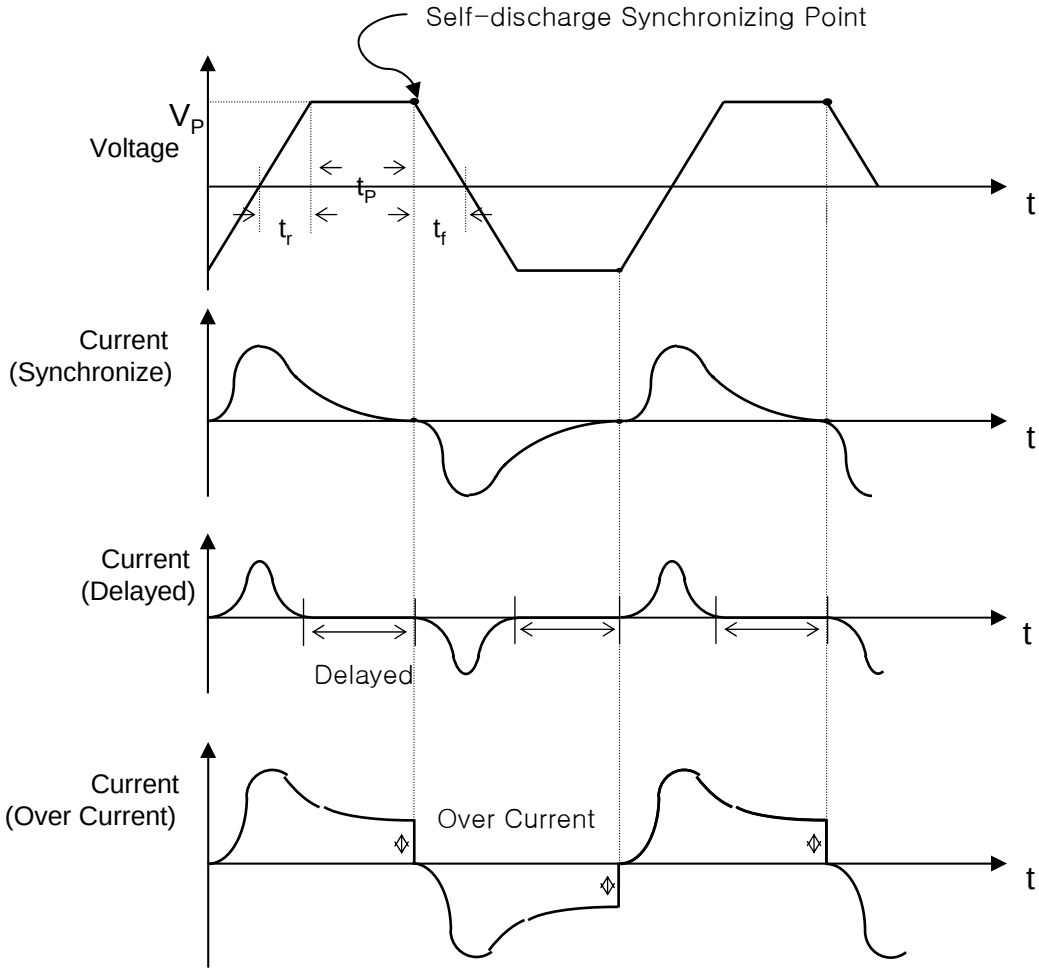


b) Sustaining Voltage



c) Falling Voltage





EEFL Driven by a Switching Inverter

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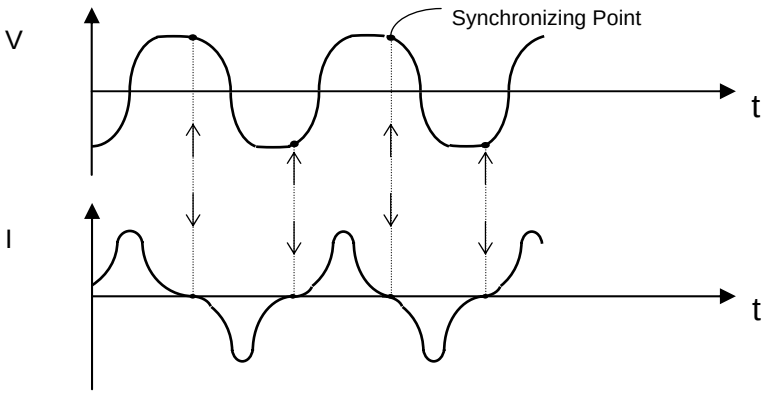
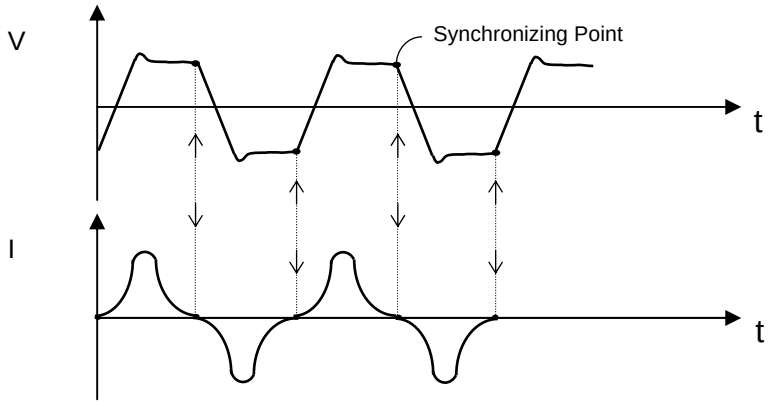
Self-Dischage Synchronized Wave Formulas

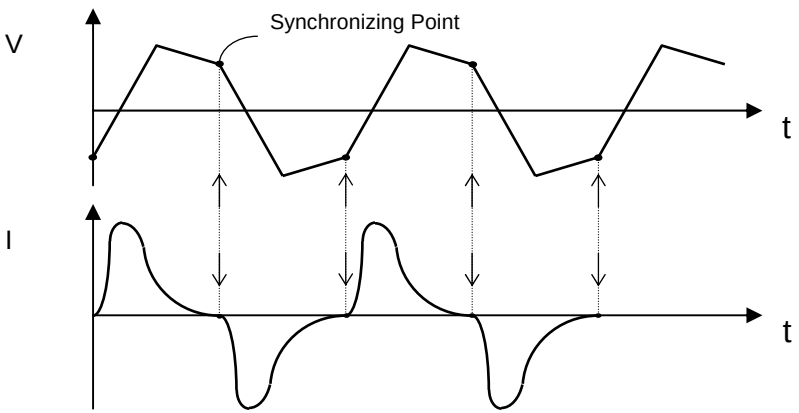
a) Rounded Wave



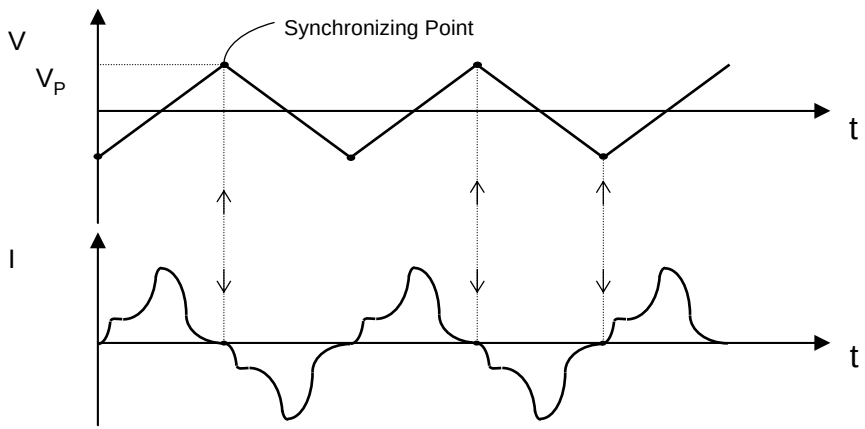
b) Over-Shot



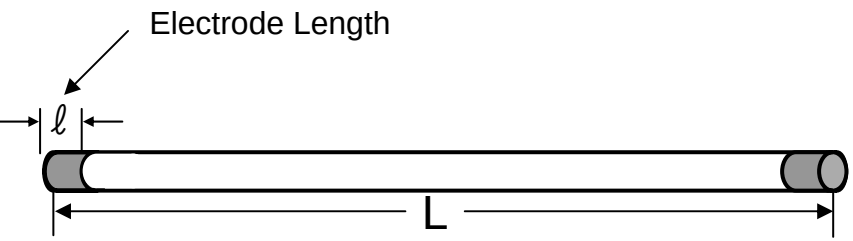
C) Sloped



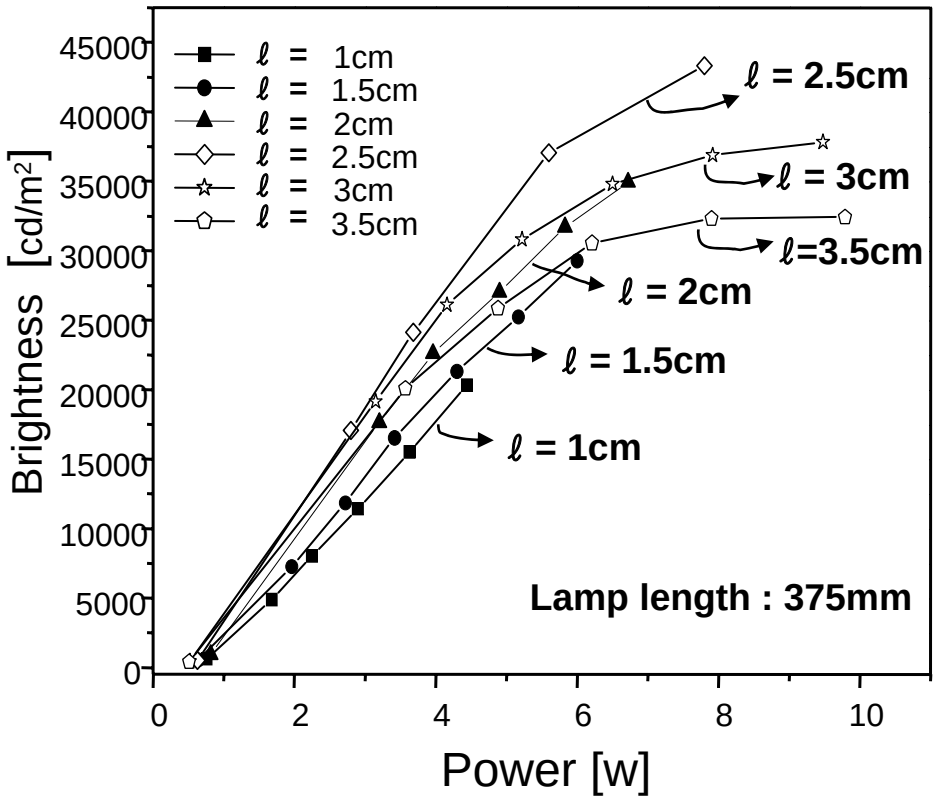
d) Sawtooth

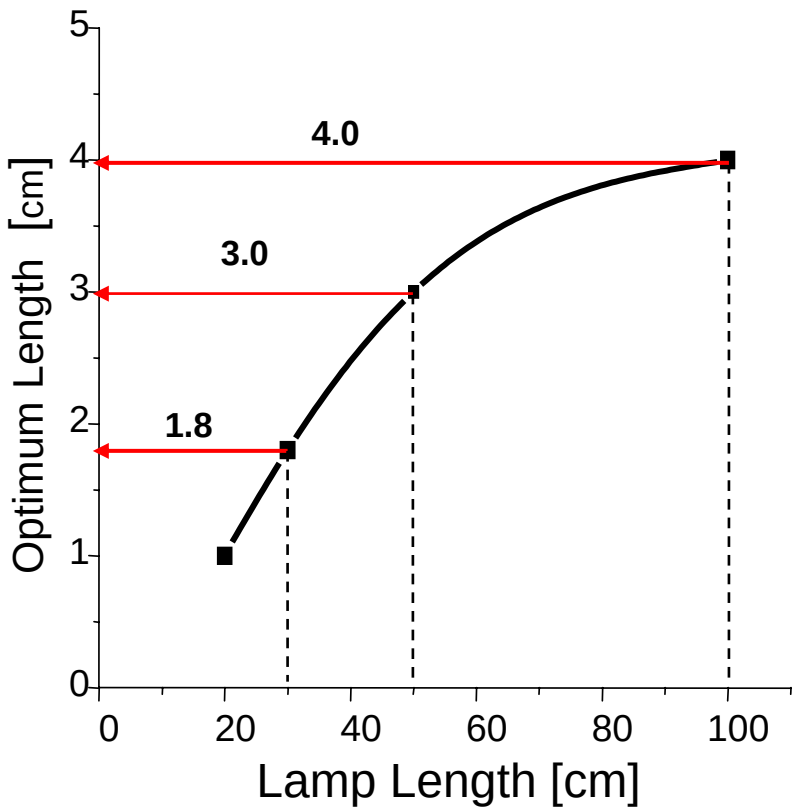


EEFL Electrode Structure



- **Optimum Electrode Length**

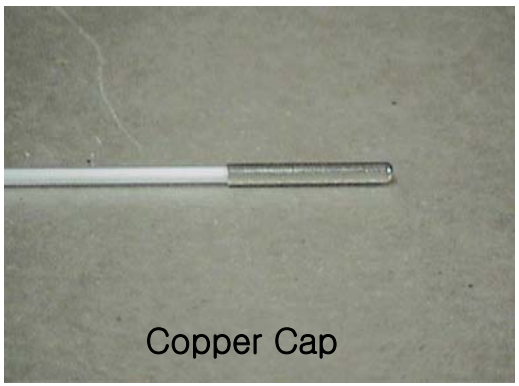


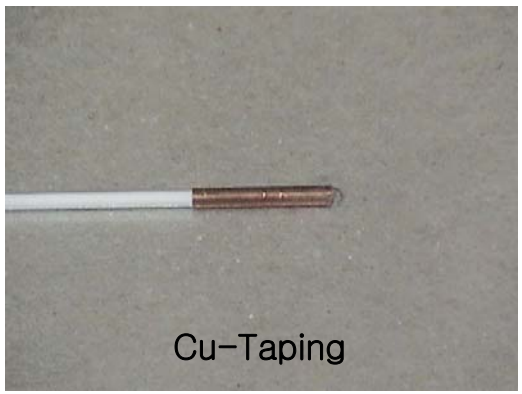


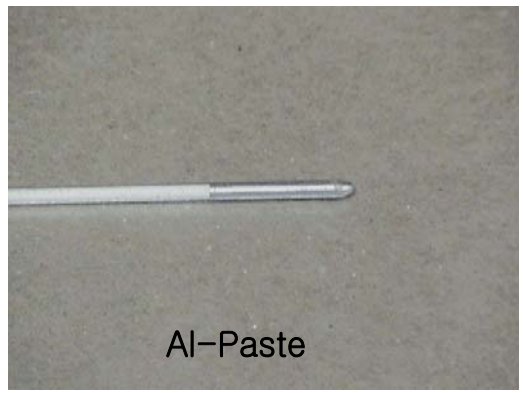
EEFL Electrode Structure

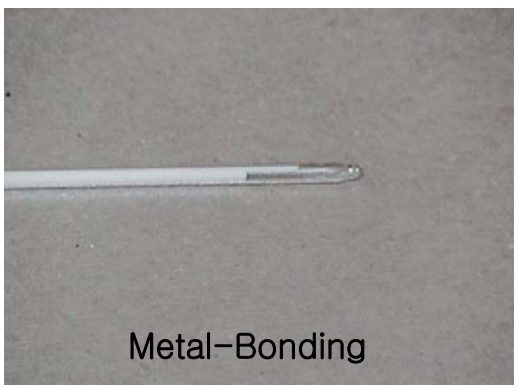
Electrode Formation Methods

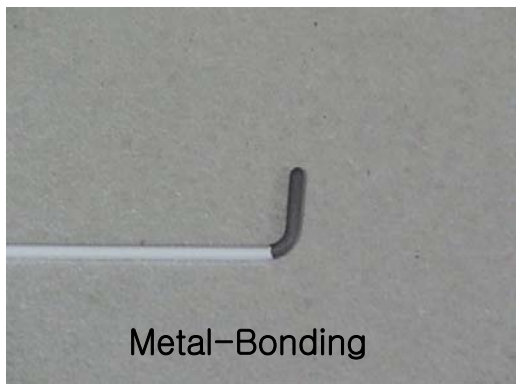
1) Metal Cap (Copper Cap)
2) Metal Foil Taping
3) Metal Plating
4) Metal–Glass Melt-Bonding











EEFL Electrode Structure

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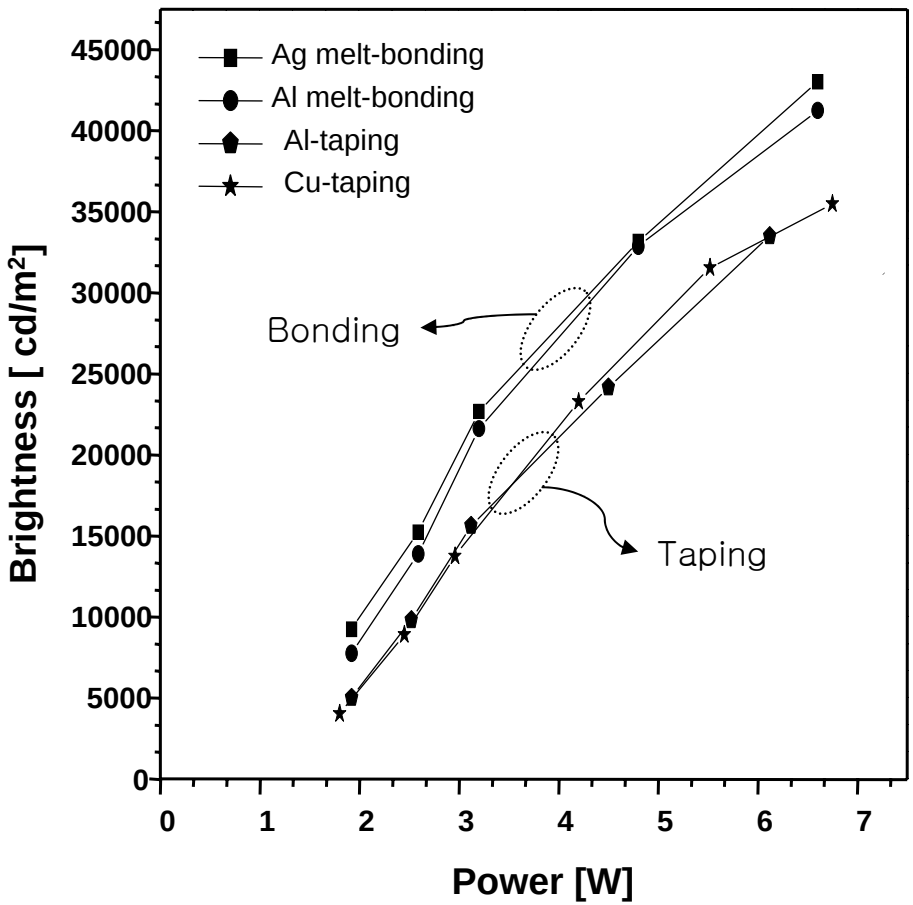
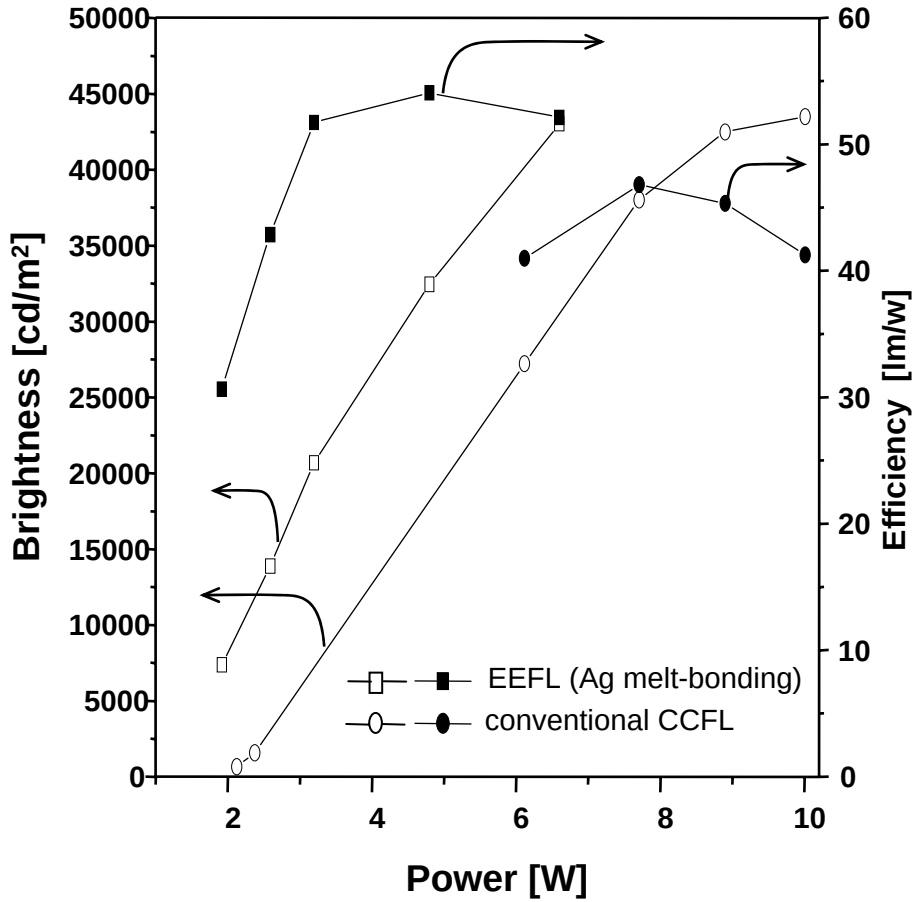
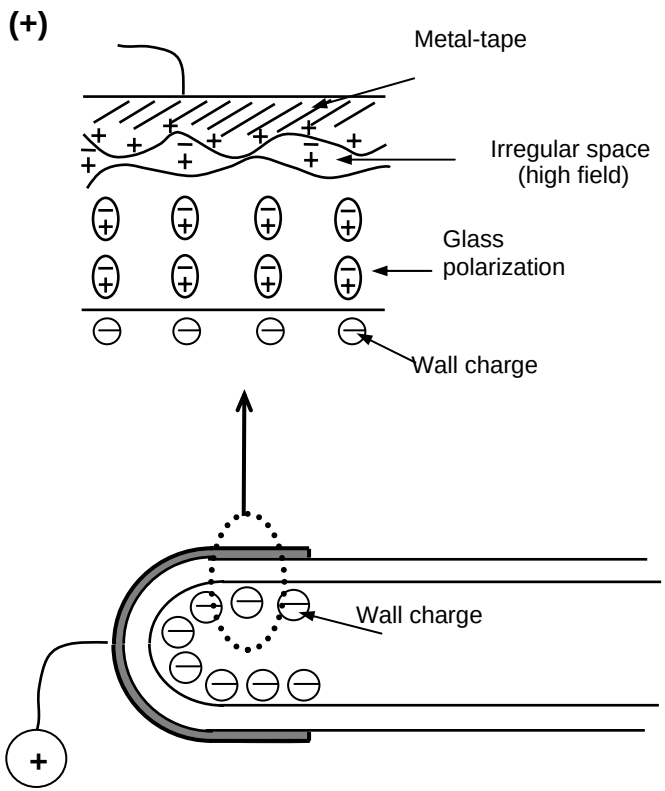


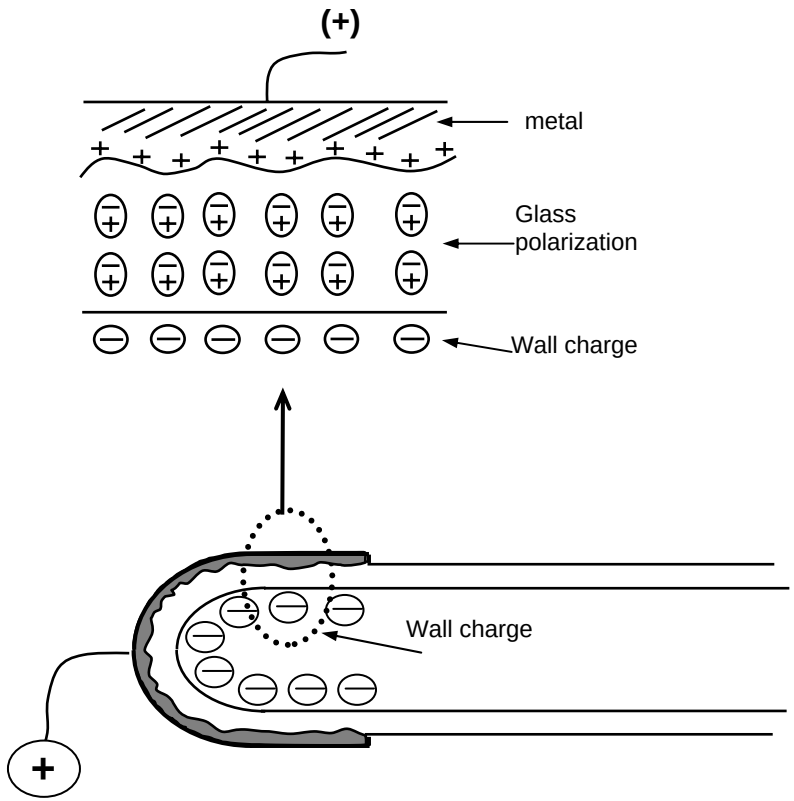


Metal–Glass Melt–Bonding Technology

- **Metal–taping (Low Capacitance)**



- **Metal–glass melt–bonding (High Capacitance)**



Various EEFL-Lamps

-Color EEFL Lamps

Various EEFL-Lamps

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Various EEFL-Lamps

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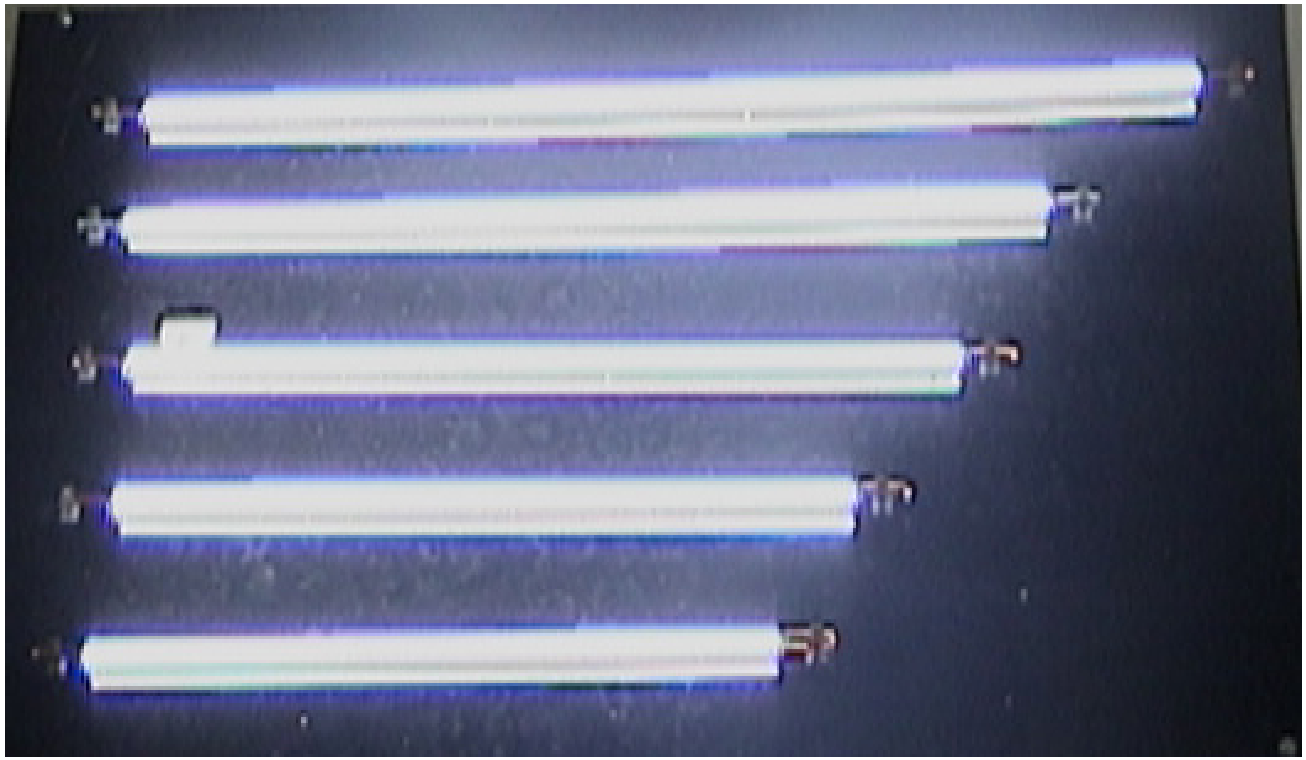


450 mm

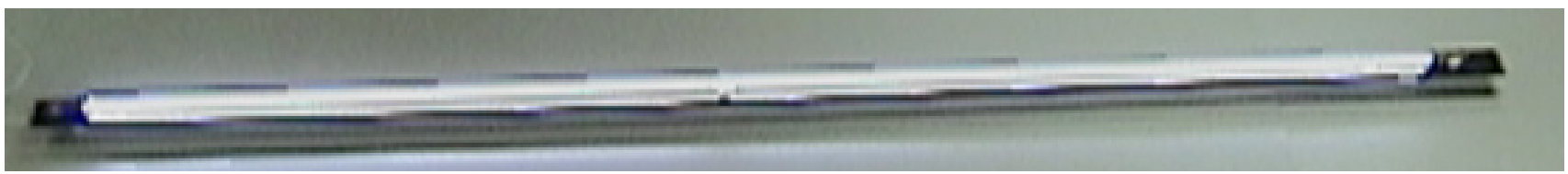
393 mm

355 mm

314 mm

291 mm

1000 mm



EEFL–Edge Lighting Backlight

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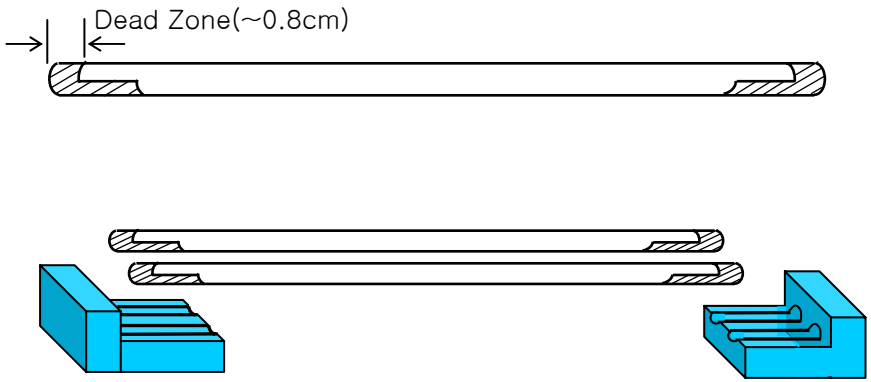
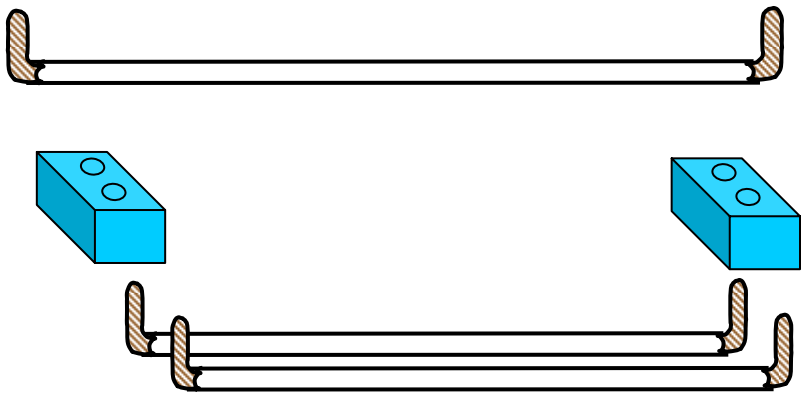
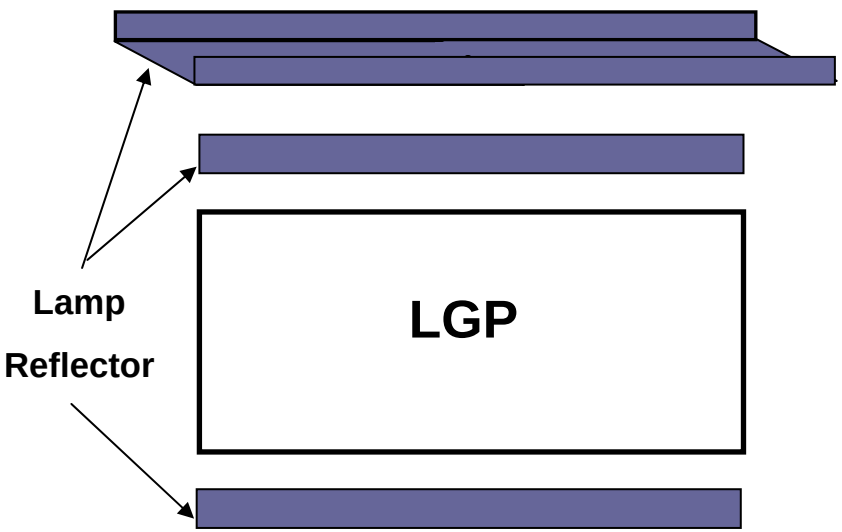
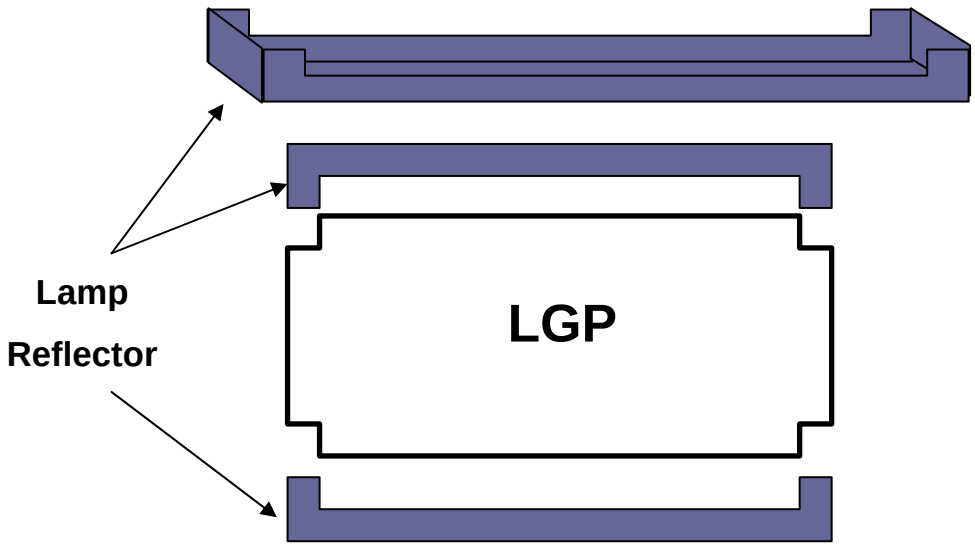
1) Elongated Bottom Electrode



2) Bended Electrode







EEFL–Backlight (Edge–Lighting)

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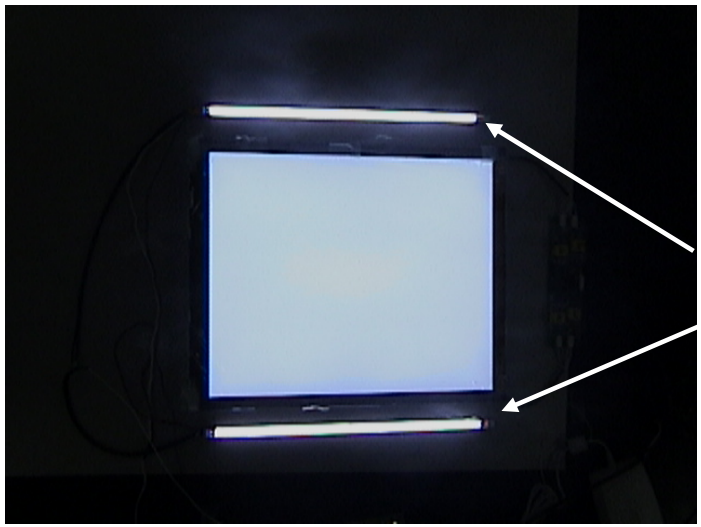
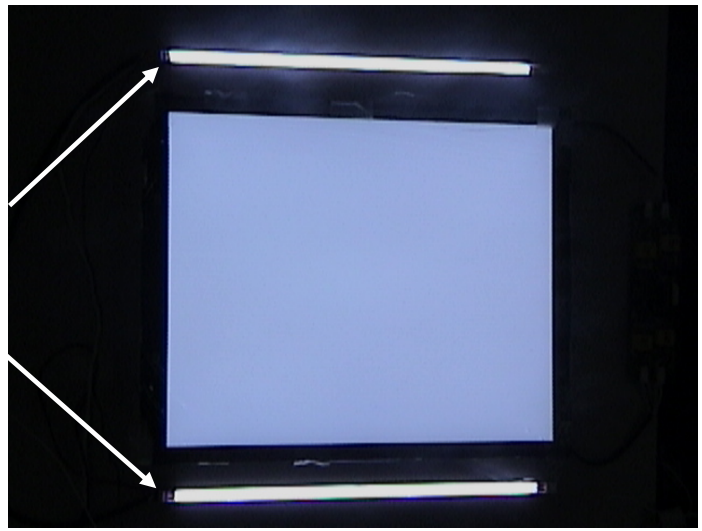
17″ Panel

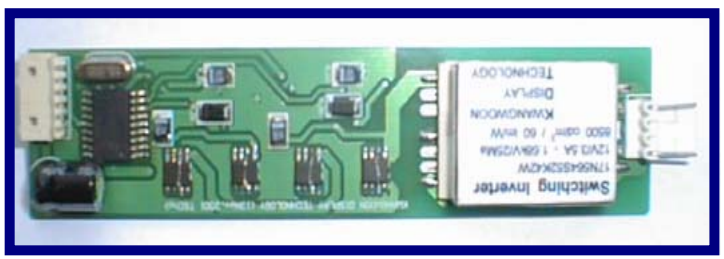
19″ Panel



Reflector

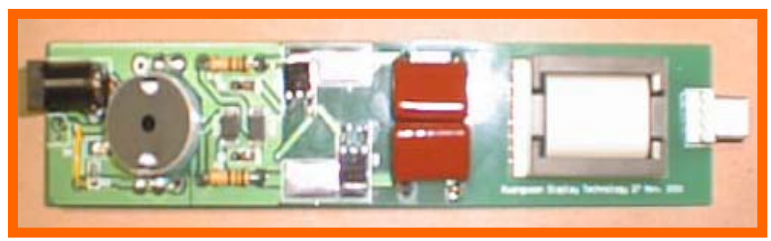


Full-Bridge Switching Inverter



(12 * 3 * 1) (cm)

Multi-Vibrator Switching Inverter



(15 * 3 * 1) (cm)

EEFL–Direct Lighting Backlight

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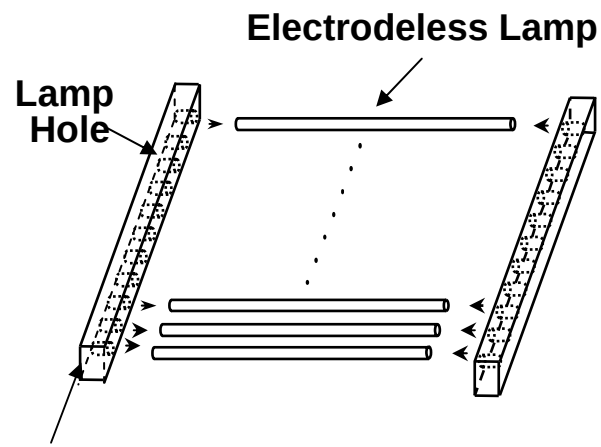
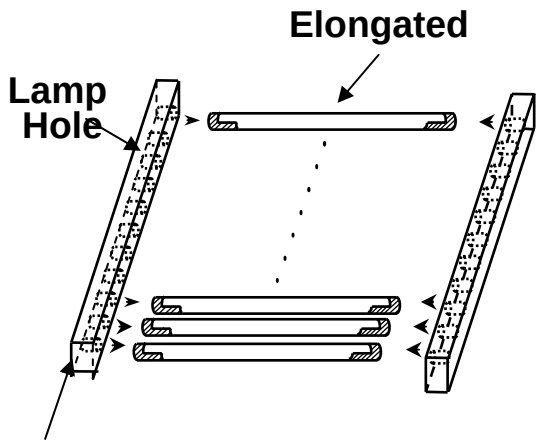
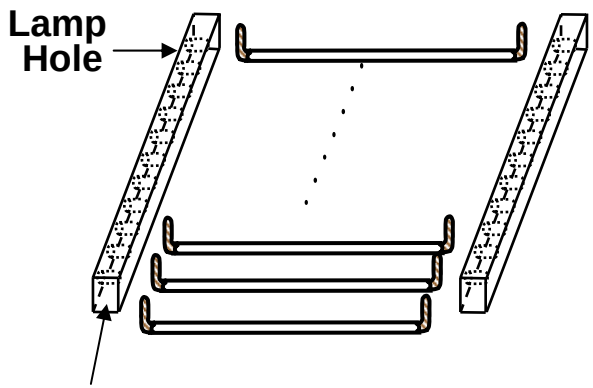
Type1 : Electrodeless Lamps	Type2 : Elongated EEFLs	Type3:Bended EEFLs
 Lamp Connector (Conductive Lubber Inside Hole)	 Lamp Connector (Copper Inside Hole)	 Lamp Connector (Copper Inside hole)
- Simple Connection - Low Efficiency ~50 lm/W	- Narrow Dead Zone - High Efficiency ~ 60 lm/W	- Narrow Dead Zone - High Efficiency ~ 60 lm/W

EEFL–Backlight (Direct–Lighting)

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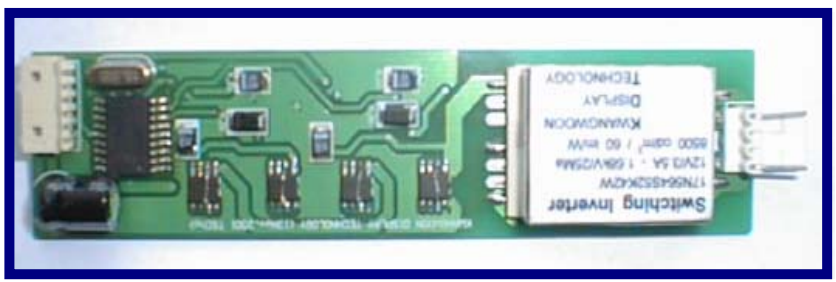
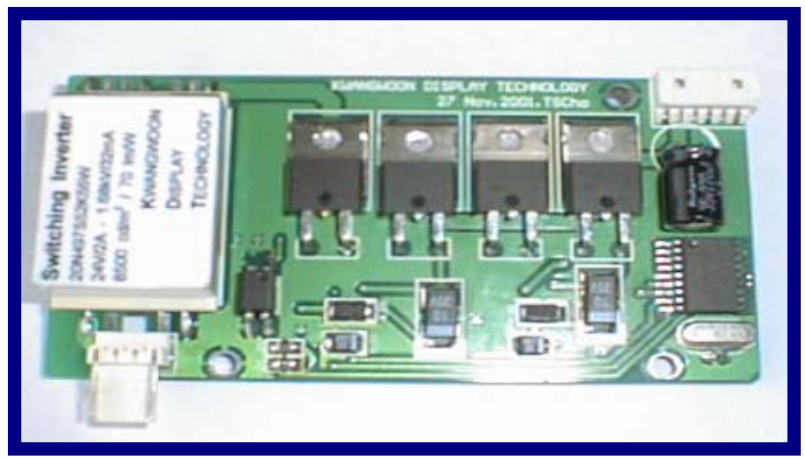
20.1″ Panel

Diffusion Plate Opened



(12 * 3 * 1) (cm)



(9.5 * 4.8 * 1) (cm)

EEFL–Backlight (Direct–Lighting)

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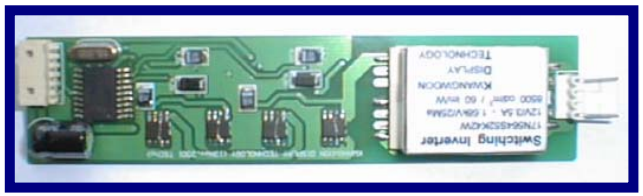
Full bridge Switching Inverter

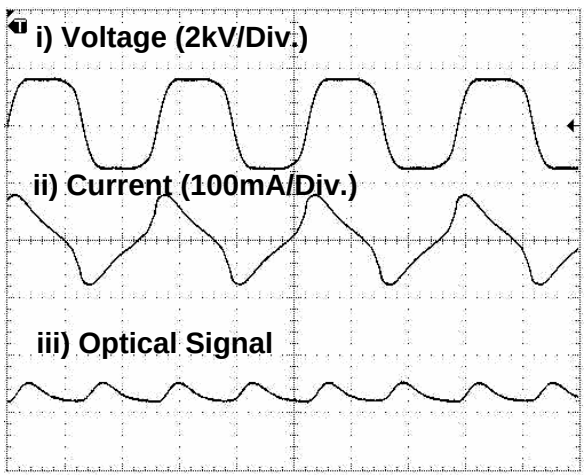


(12 * 3 * 1) (cm)

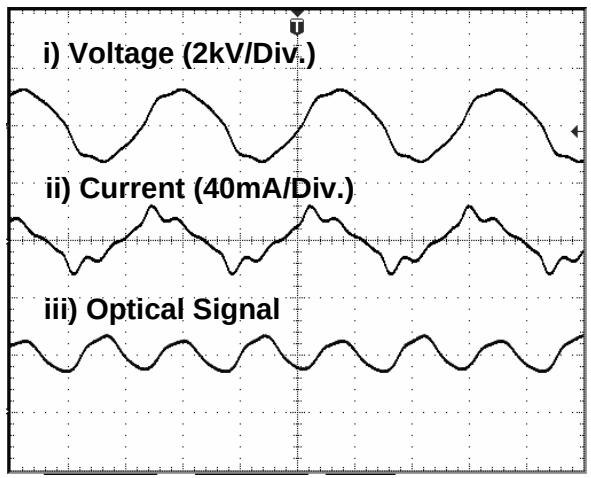
Multi-Vibrator Switching Inverter

(15 * 3 * 1) (cm)

12 - EEFLs



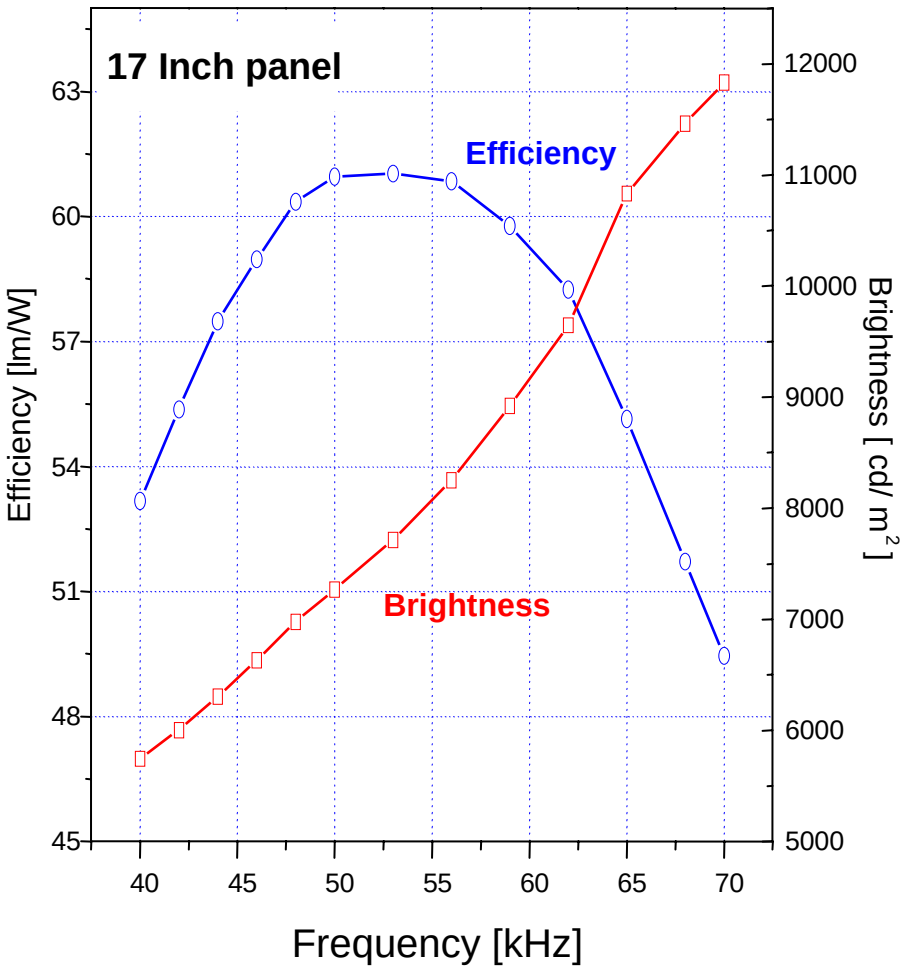
12 - EEFLs

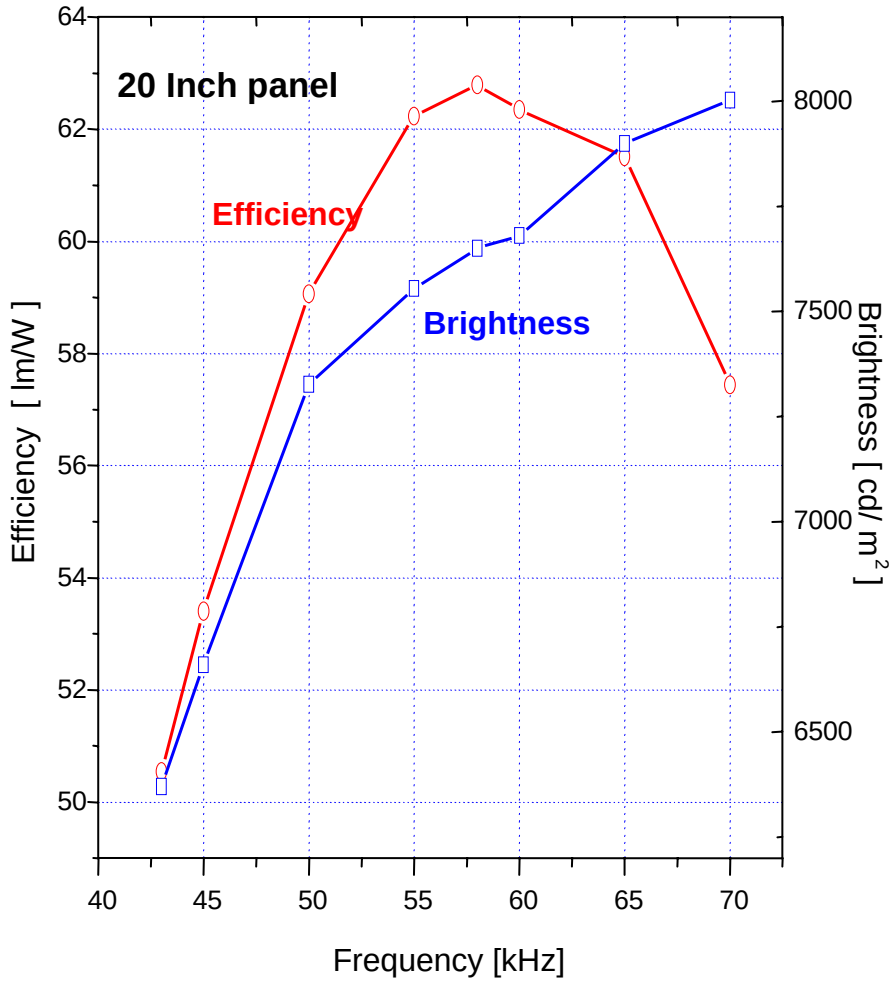


EEFL-Backlight (Direct –Lighting)

Confidential

Cu-Taping Electrode

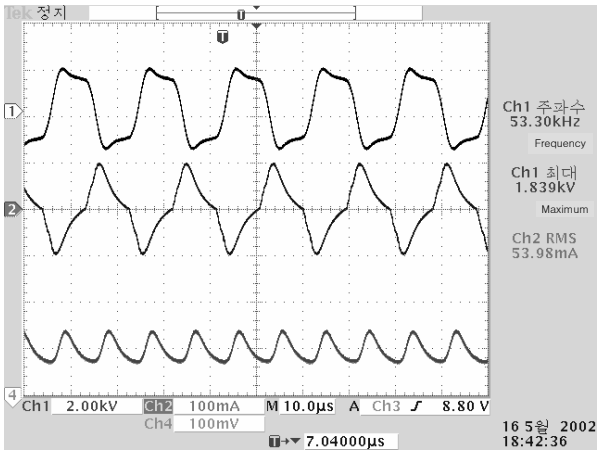


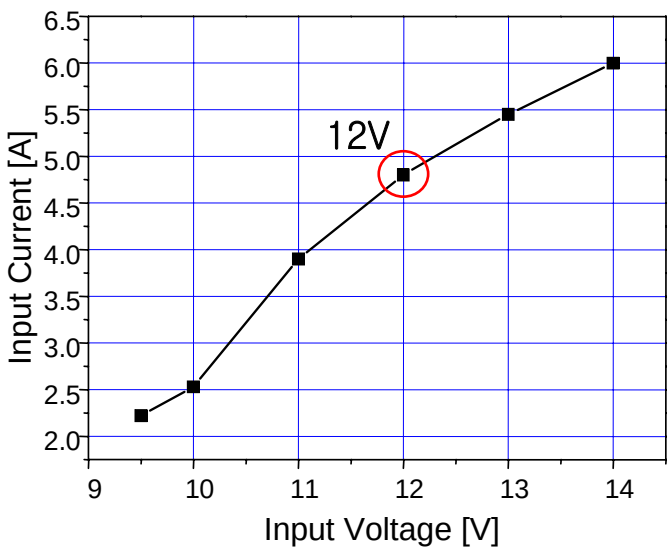


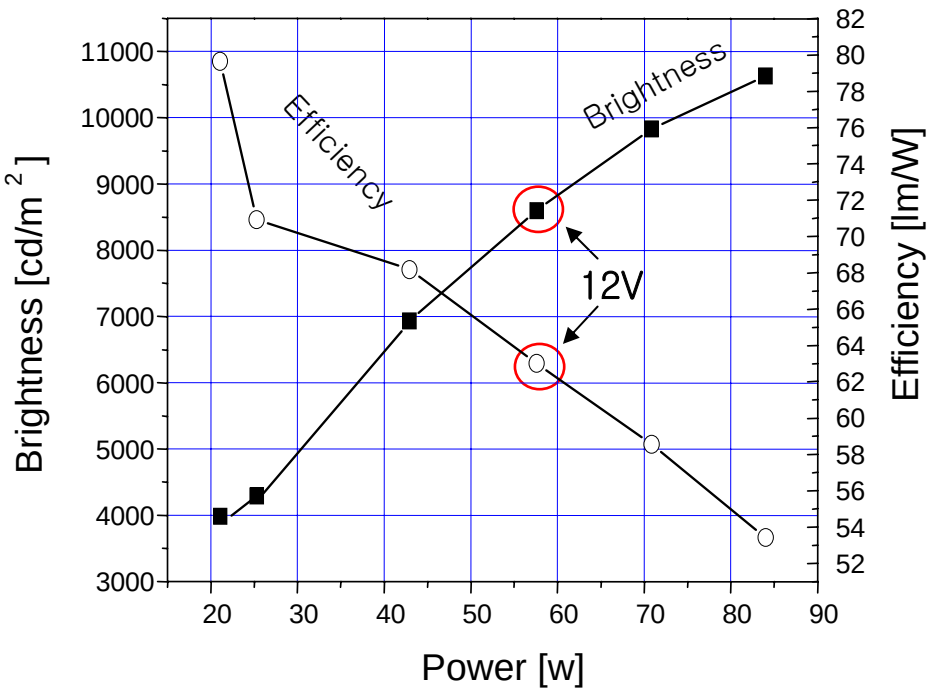
EEFL-Backlight (Direct –Lighting)

Confidential

20.1 Inch (Input : 12V) : Metal-Bonding Electrode



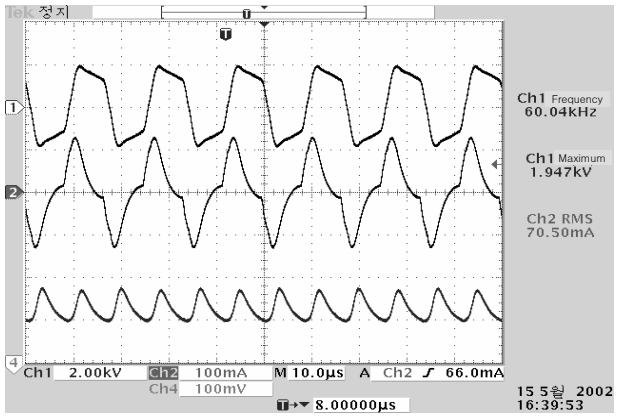


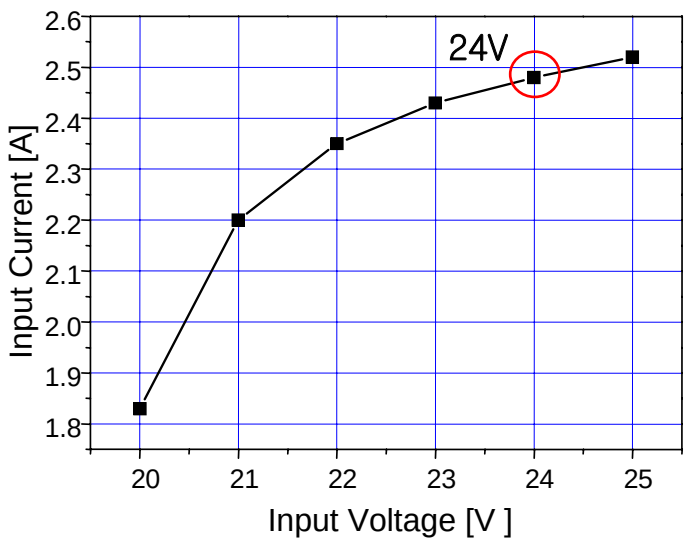


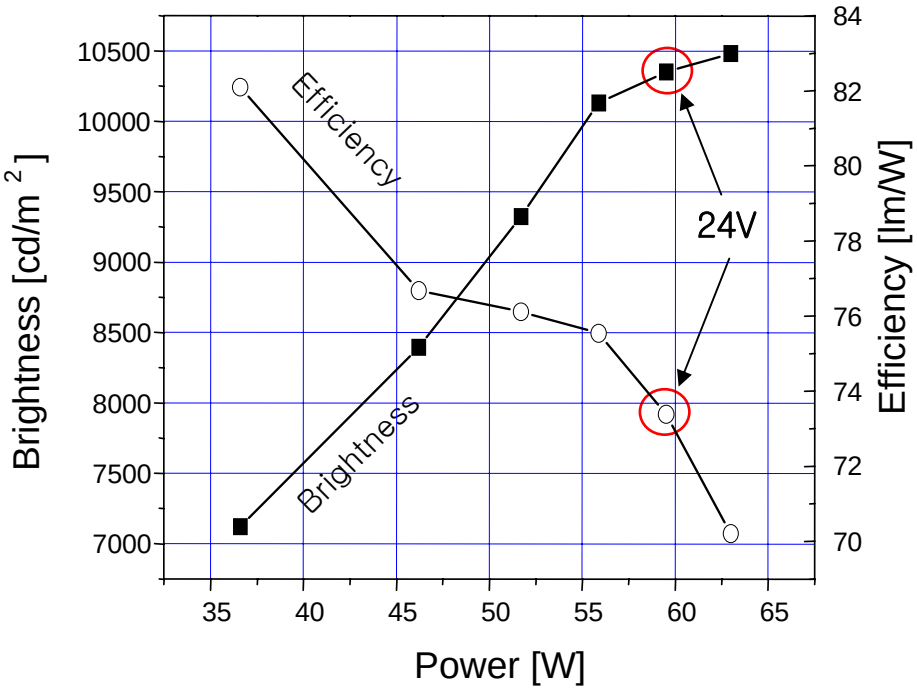
EEFL-Backlight (Direct –Lighting)

Confidential

20.1 Inch (Input : 24 V) : Metal-Bonding Electrode



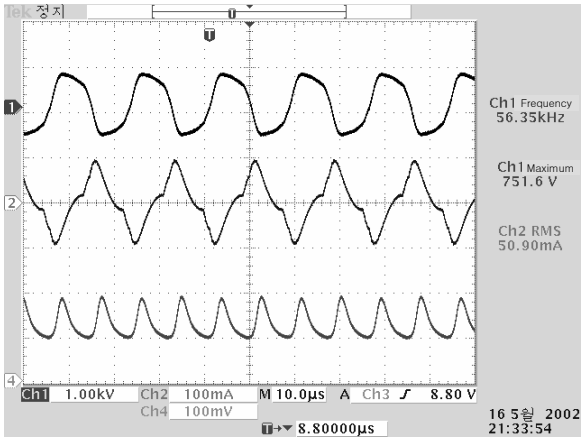


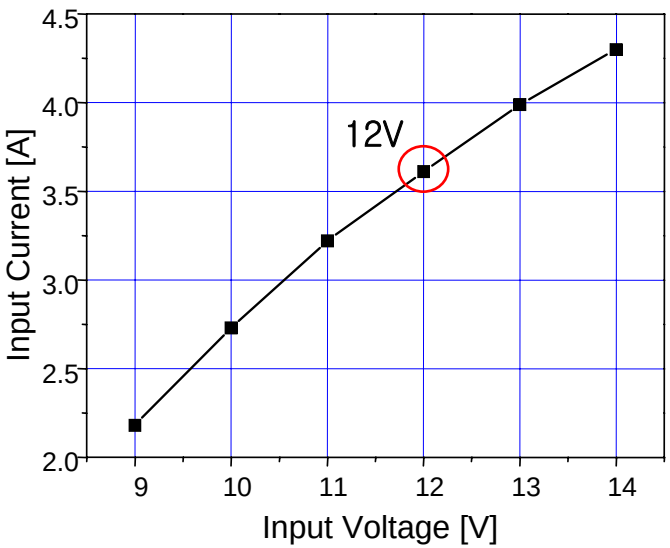


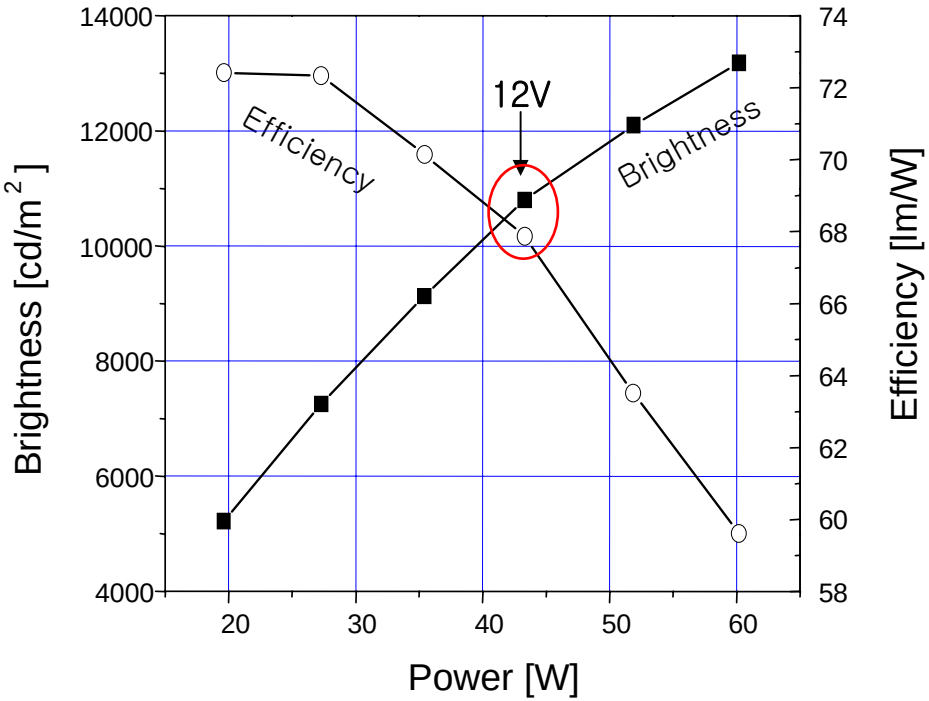
EEFL-Backlight (Direct –Lighting)

Confidential

17 Inch (Input :12V) : Metal-Bonding Electrode







EEFL–Backlight specification

Confidential

- Metal Bonding External Electrode

	Conventional Edge-Lighting	Direct Lighting		
panel	17 inch 38.4*28*2(cm)	17 inch 38.4*28*2(cm)	20.1 inch 44.5*31*2(cm)	
Tubes	4- lamps	12 - lamps	14 - lamps	
Inverter size	LC-Resonance 16*4.5*1 (cm)	Full Bridge 12*2.8*1(cm)	Full Bridge 9.5*4.8*1(cm)	
Input	12V/ 1.7A	12V/ 3.61A	12V/ 4.68A	24V/ 2.48A
Input Power	20 W	43 W	56 W	59 W
Frequency	50 KHz	56 KHz	53 KHz	59 KHz
Brightness	3,500 cd/m^2	11,000 cd/m^2	8,650 cd/m^2	10,300 cd/m^2
Efficiency	50 lm/W	70 lm/W	64 lm/W	73 lm/W

A large Area Backlight about 40 inch in diagonal

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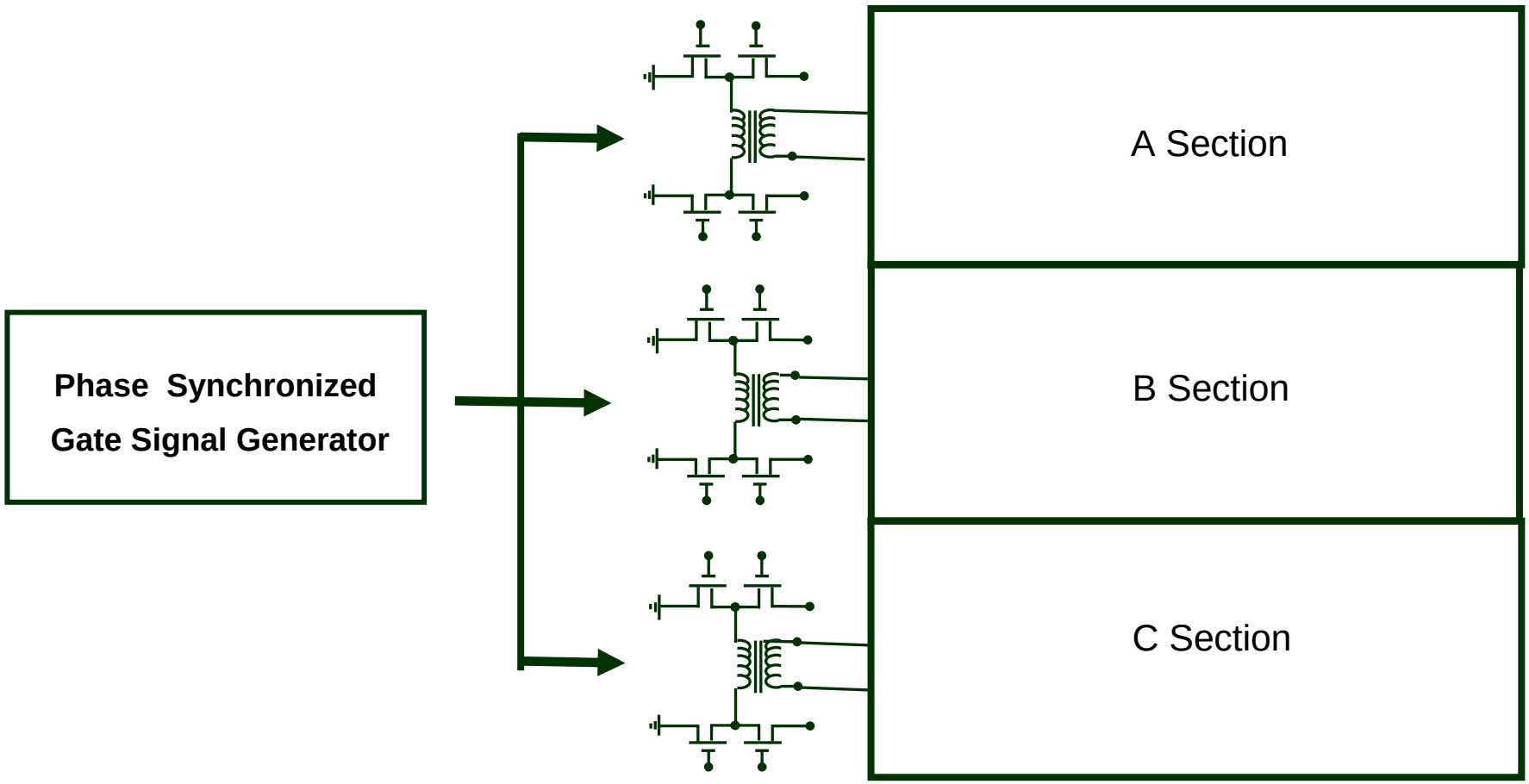
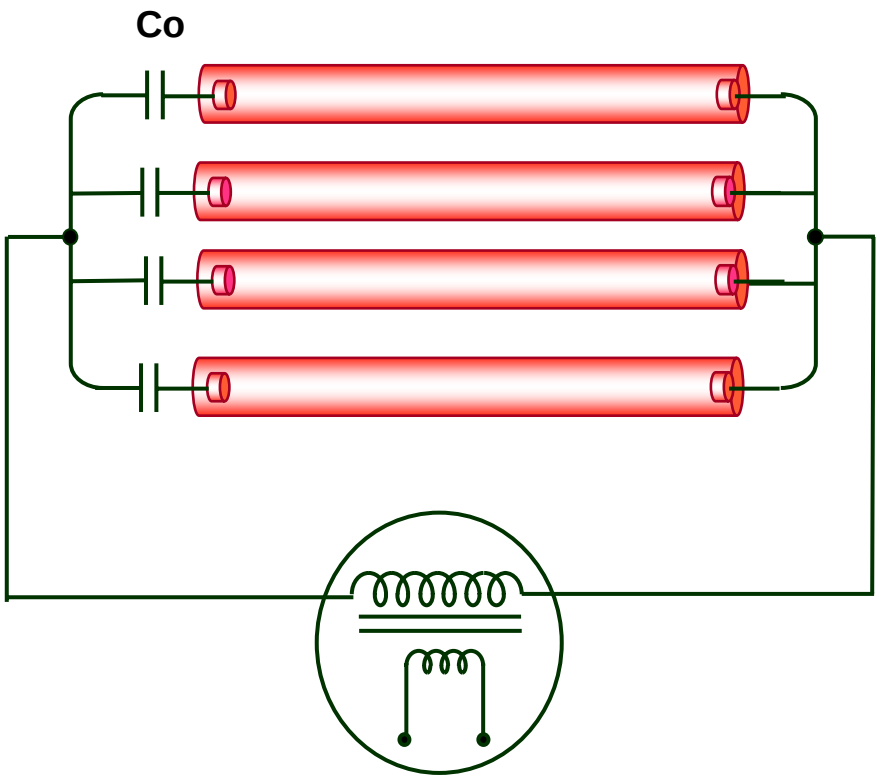


Multi-CCFLs Driven by a Switching Inverter

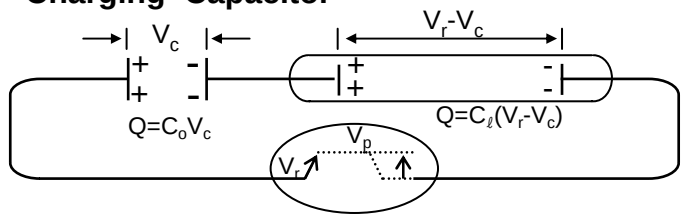
Confidential

- **Self Discharge Synchronizing provides a high Efficiency**

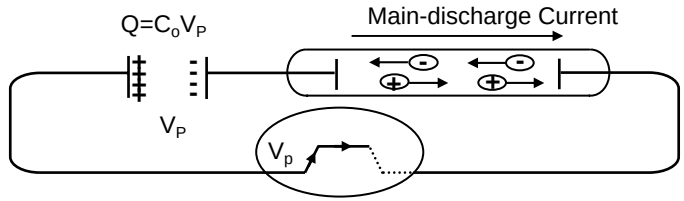


- **Co : Synchronizing Capacitor for the Uniformity**

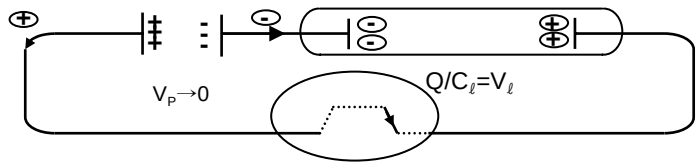
a) Rising Voltage : Charging Capacitor



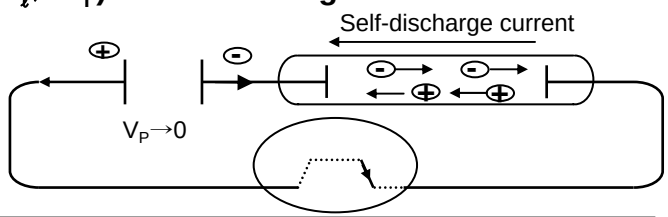
b) Rising & Sustaining : Main discharge ($V_r - V_C \rangle V_f$)



c) Falling Voltage : Charging Lamp



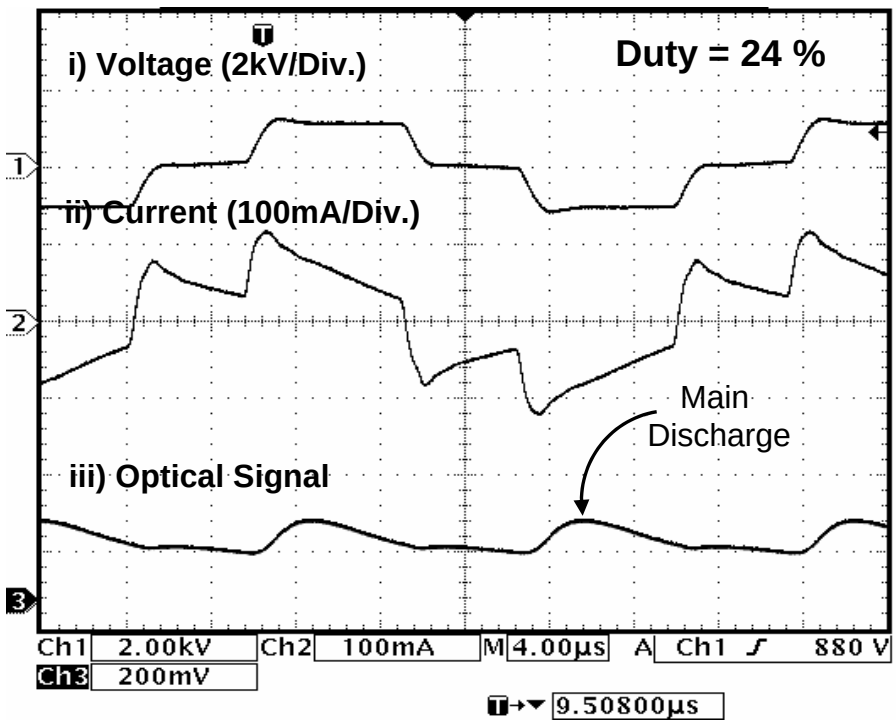
d) Falling Voltage ($V_\ell \rangle V_f$) : Self-discharge



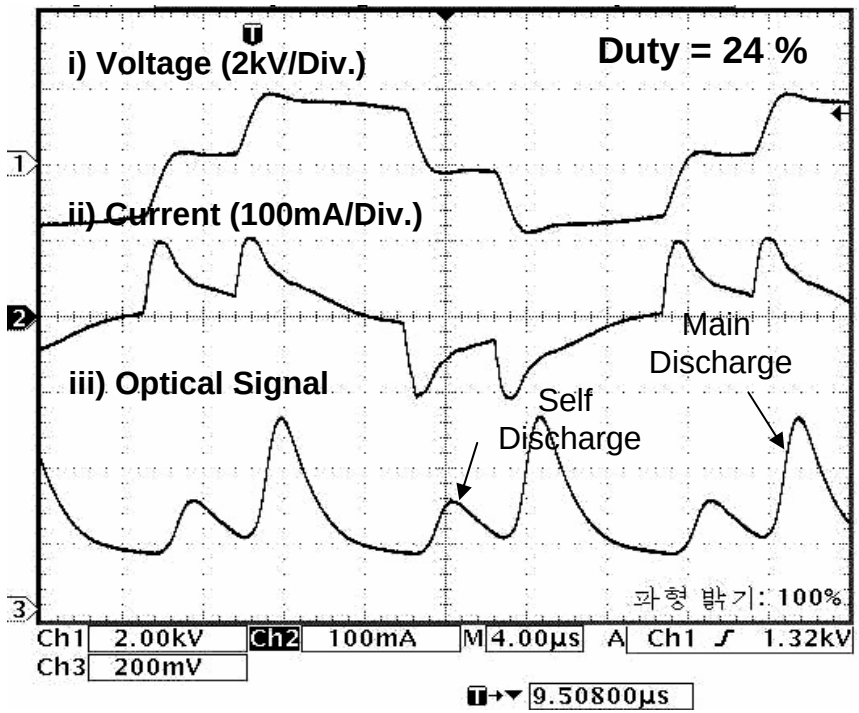
Multi-CCFLs Driven by a Switching Inverter

- **Self-discharge in Multi-CCFLs with an optimum Ballast Capacitor**

(a) C_o = 47 pF (Without Self-discharge)



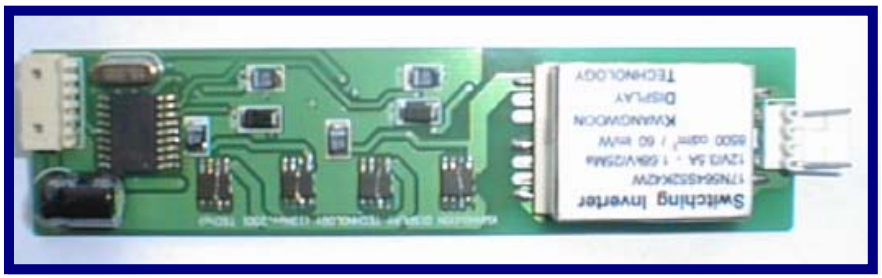
(b) C_o = 18 pF (With Self-discharge)



CCFL Backlight (Direct–Lighting)

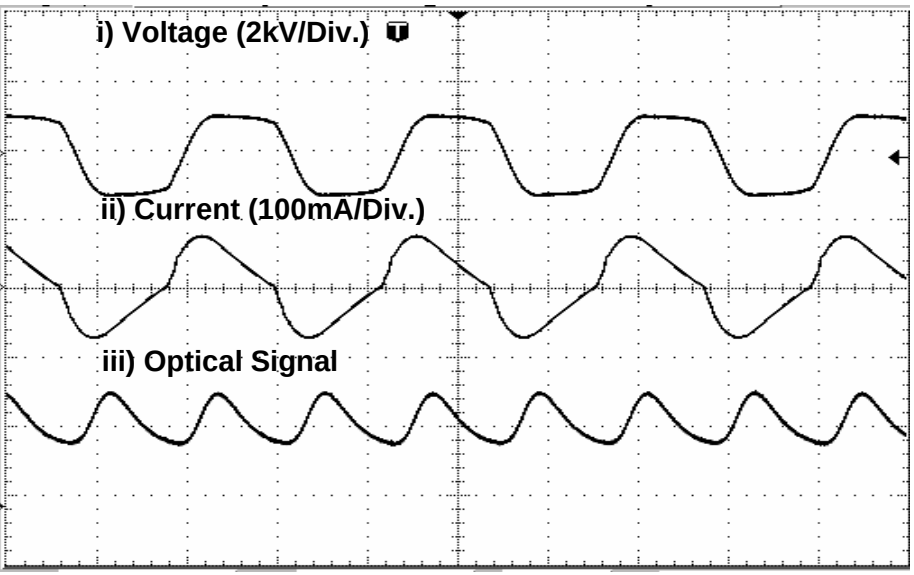
Confidential

1) Full bridge Switching Inverter

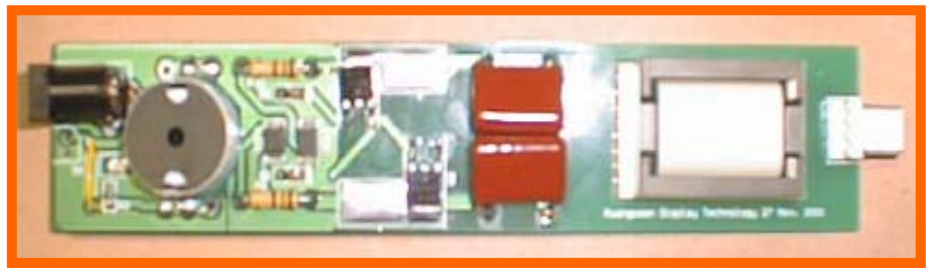


(12 * 3 * 1) (cm)

- 12 – CCFLs : 17 inch Panel

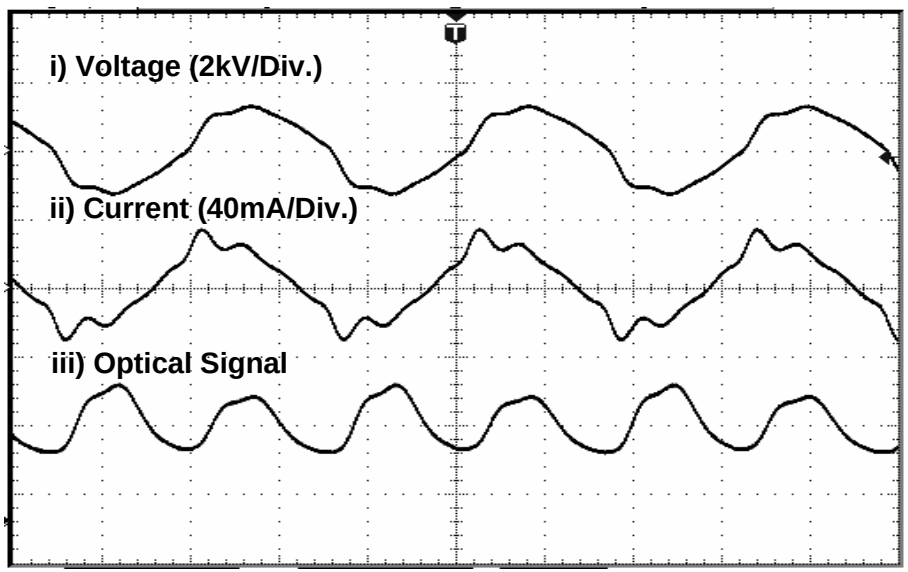


2) Multi-Vibrator Switching Inverter



(15 * 3 * 1) (cm)

- 12 – CCFLs : 17inch Panel



Conclusions

1. **High Brightness & High Efficiency EEFLs ;**
   - External Electrode Formulated by Metal-Glass Melt-Bonding
   - A Self-Discharge Synchronizing Operation
   - By a Switching Inverter

2. **Edge-Lighting EEFLs-Backlight Panels ;**
   - A good Uniformity obtained with single Transformer on a single Stage Inverter.

3. **Direct-Light EEFLs-Backlight Panels of 17 & 20.1 inch in Diagonal**
   - High Luminance of 7,000 ~ 10,000 cd/m^2
   - High Efficiency of 70 ~ 80 lm/w

   (With single Transformer on a single Stage Inverter.)

EEFL-Backlight & Switching Inverter promise a new generation of LCD Backlight & Operation

- Low Power consumption
- Long Life Time
- High Brightness Backlight Up to ~ 10,000 cd/m^2
- High Efficiency Up to ~ 70 lm/W
- Application to a Large Size Backlight Up to 1m×1m inch LCD
- Low Cost
- Simple Assembly

< Ref from Presentation at SID'02 Boston by KDT >