WeEn Semiconductors

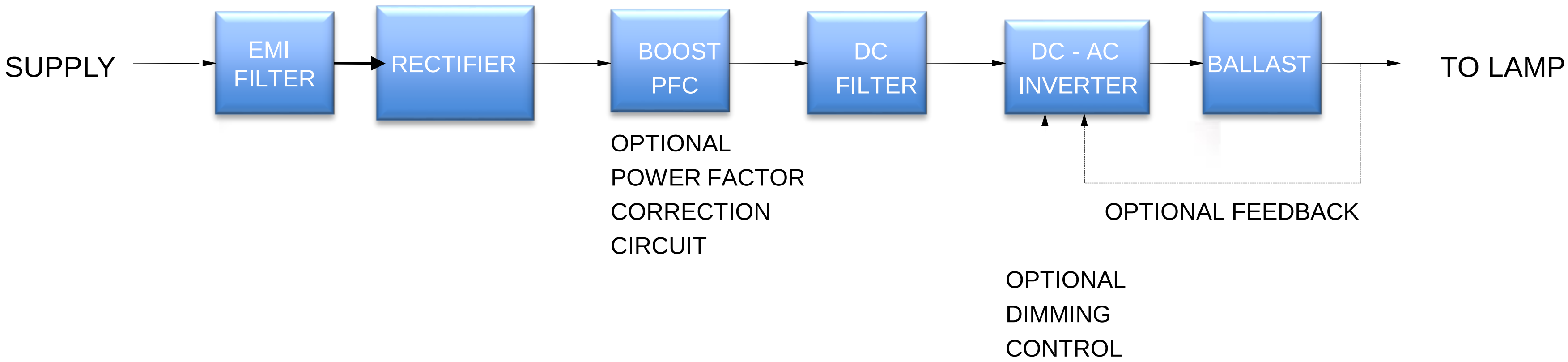
Application Team

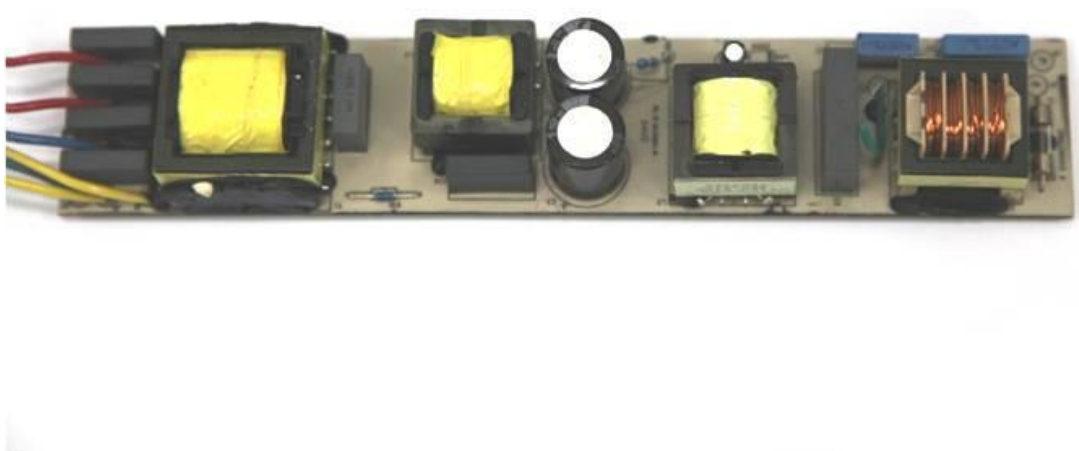
March,2017

Electronic lighting

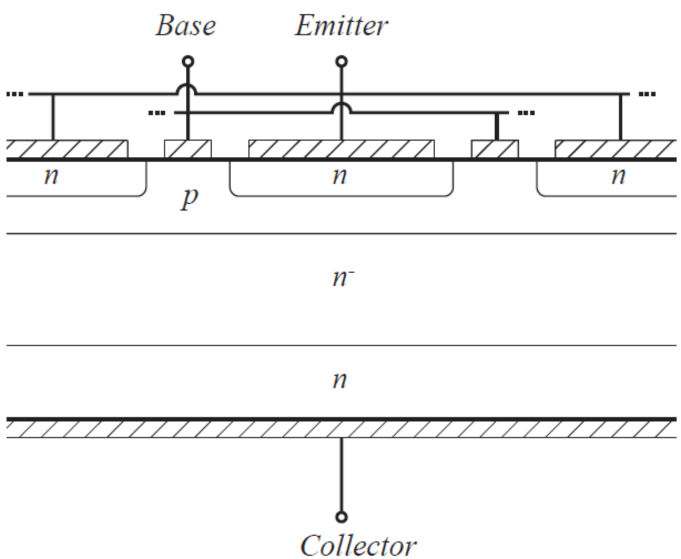
- Main focus applications:
- High frequency fluorescent lamp ballasts
- **C**ompact **F**luorescent **L**amps
- Electronic transformers for Low Voltage Tungsten Halogen Lamps

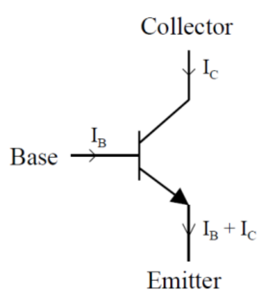
Electronic ballast block diagram

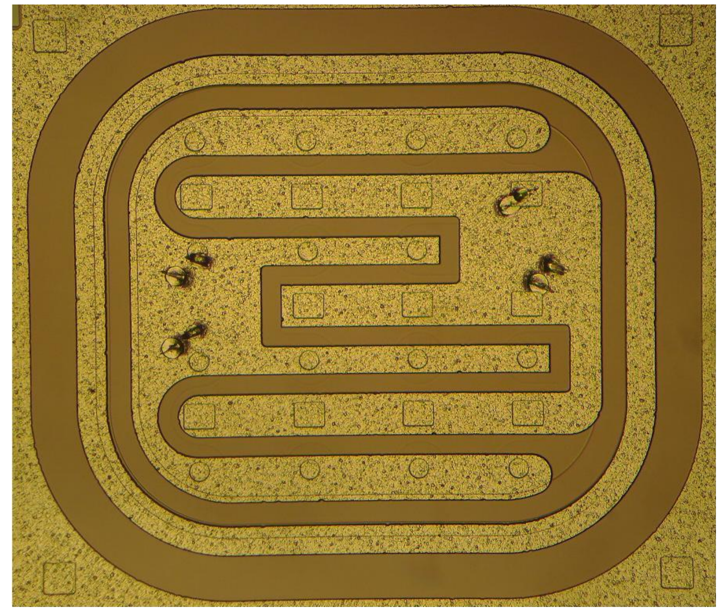




Bipolar High Voltage Transistor





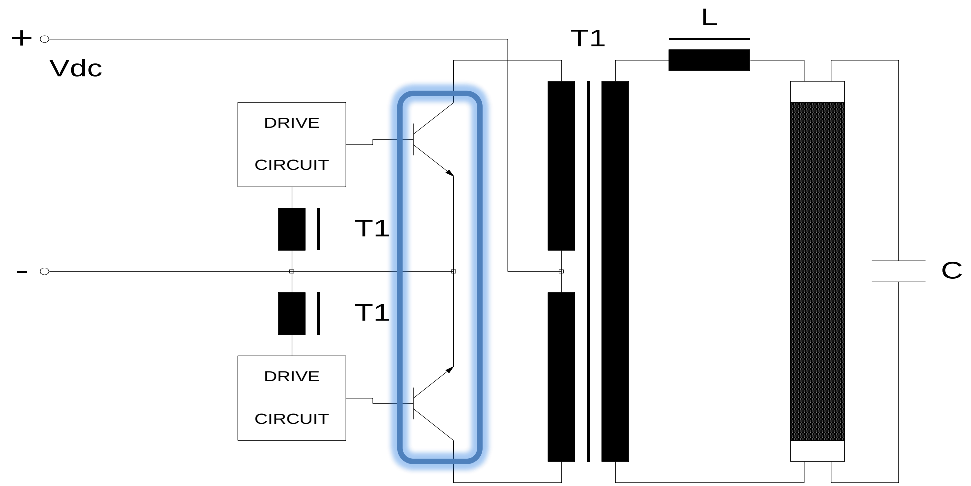


High Voltage Transistor Chip

WeEn supplies the most critical devices - High voltage transistor- for DC-AC inverter

Inverter circuits

1. Voltage Fed Push Pull (VFPP)

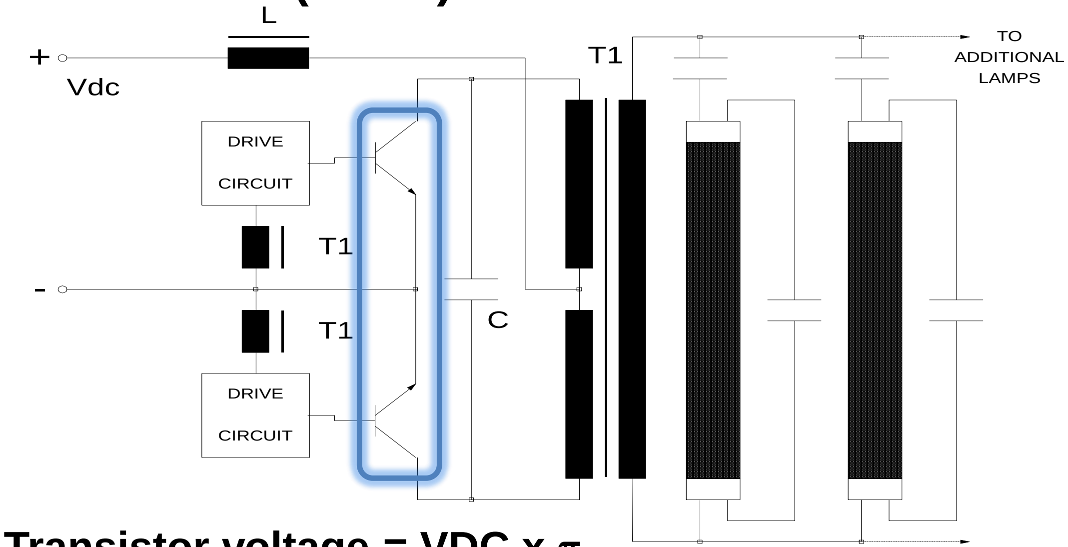


Transistor voltage = V_{DC} x 2

V_{CESM}	$I_{C(DC)}$	25ºC ind. t_f	@ I_C	h_{FE}	@ I_C	SOT78(TO-220AB)	SOT186A(TO-220F)	SOT428(DPAK)
(V)	(A)	(ns)	(A)		(A)			
1000	5	145	2.5	12	3	BUJ303A	BUJ303AX	BUJ303AD
1050	4					BUJ302A	BUJ302AX	BUJ302AD
1050	5	200	2.5	10.5	3	BUJ303B		BUJ303CD
1200	6	170	2.5	15.5	3	BUJ403A		

Inverter circuits

2. Current Fed Push Pull (CFPP)

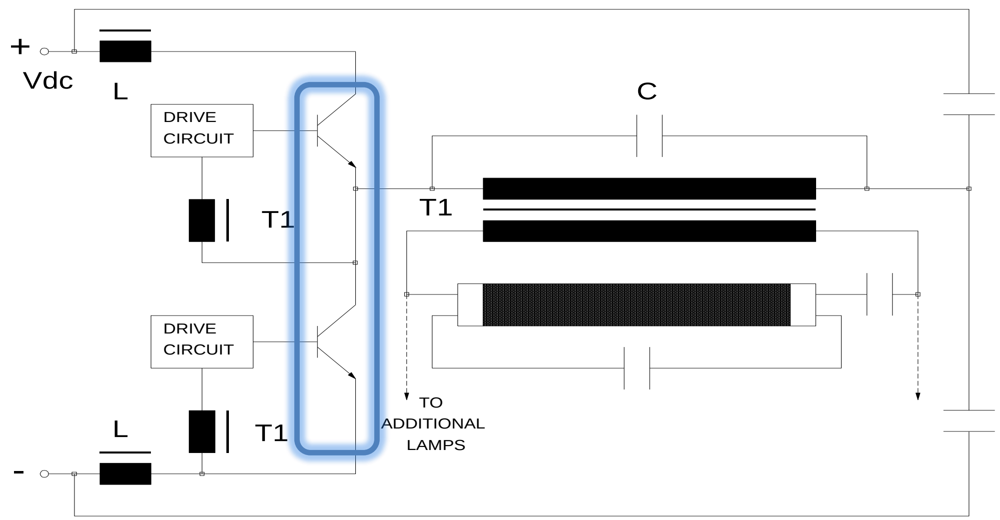


Transistor voltage = VDC x π

V_{CESM}	$I_{C(DC)}$	25ºC ind. t_f	@ I_C	h_{FE}	@ I_C	SOT78(TO-220AB)
1200	6	170	2.5	15.5	3	BUJ403A

Inverter circuits

3. Current Fed Half Bridge (CFHB)

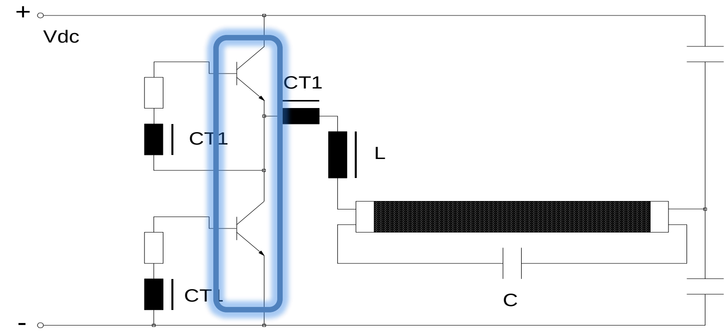


Transistor voltage = VDC x π / 2

V_{CESM}	$I_{C(DC)}$	25ºC ind. t_f	@ I_C	h_{FE}	@ I_C	SOT78(TO-220AB)	SOT186A(TO-220F)	SOT428(DPAK)
(V)	(A)	(ns)	(A)		(A)			
1000	5	145	2.5	12	3	BUJ303A	BUJ303AX	BUJ303AD
1050	4					BUJ302A	BUJ302AX	BUJ302AD
1050	5	200	2.5	10.5	3	BUJ303B		BUJ303CD
1200	6	170	2.5	15.5	3	BUJ403A		

Inverter circuits

4. Voltage Fed Half Bridge (VFHB)



Transistor voltage = VDC

V_{CESM}	$I_{C(DC)}$	25ºC ind. t_f	@ I_C	h_{FE}	@ I_C	SOT54	SOT78	SOT186A	SOT404	SOT428
	(max)	(typ)		(typ)		(TO92)	(TO220AB)	(isolated	(D^2PAK)	(DPAK)
(V)	(A)	(ns)	(A)		(A)			TO220AB)		
700	1	80	1	7.5	0.8	BUJ100LR				
700	1	80	1	7.5	0.8	PHE13003A				
700	1	50	1	14	0.75	BUJ100				
700	1	320	1	15.5	0.75	TB100				
700	1.5	100	0.5	9	1	PHE13003C				
700	1.5	100	0.5	9	1	PHD13003C				
700	4	30	2	12.5	3		BUJ103A	BUJ103AX		BUJ103AD
700	4	30	2	12.5	3					BUJD103AD
700	4	100	2	17	2		PHE13005	PHE13005X		
700	4	100	2	17	2		PHD13005			-
700	8	20	5	11	4		BUJ105A		BUJ105AB	BUJ105AD
700	8	20	5	11	4					BUJD105AD
700	8	40	5	9	5		PHE13007	-		
700	8	40	5	9	5		-			
700	10	20	5	11	6		BUJ106A			
700	12	100	5	6min - 30max	8		PHE13009			
850	4	30	2	12.5	3		BUJD203A	BUJD203AX		BUJD203AD

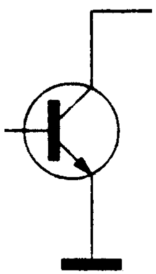
Inverter circuits
- summary

- ✓ Circuit 1 (VFPP) and circuit 2 (CFPP) are occasionally seen in the US for longer industrial lamps (8 foot)
- ✓ Circuit 3 (CFHB) is very popular in the US for basic discrete designs
- ✓ Circuit 4 (voltage fed half bridge) is universally the most popular and used for all:
  - integrated Compact Fluorescent Lamps
  - remote ballasts for CFLs and linear fluorescent lamps
  - electronic transformers for Low Voltage Tungsten Halogen Lamps

Advantages of WeEn high voltage transistor

On-state loss and switching loss

<u>On-state conduction loss</u>

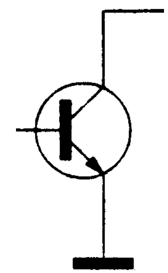


$$P_{Loss} = V_{CE} \times I_C$$

Loss can be reduced by choosing:

- High base current
- Large silicon chip (large transistor)

<u>Switching loss</u>

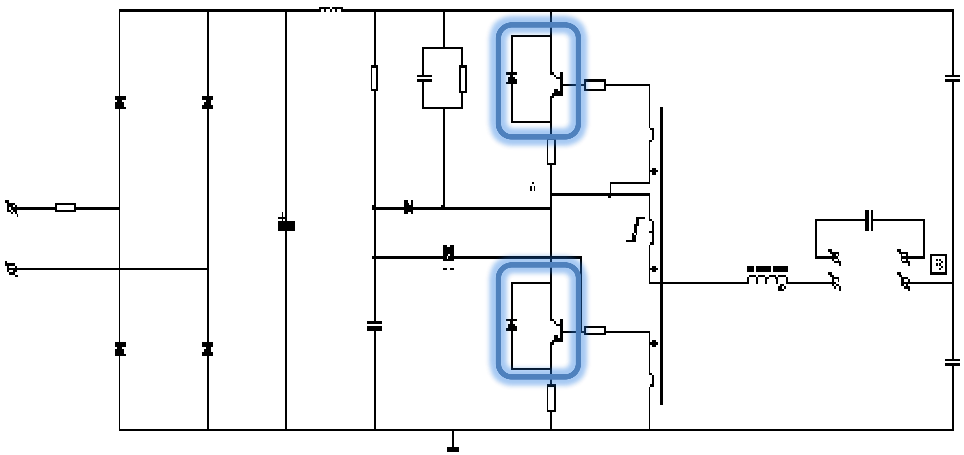


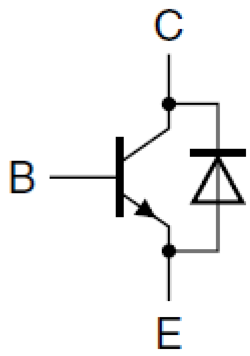
$$P_{Loss} \propto f_S \times Q_S$$

Loss can be reduced by choosing:

- Low switching frequency
- Low base current

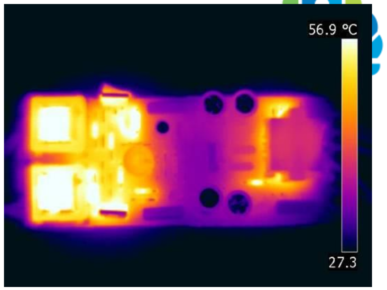
Application Benchmark





- Performance of three devices with integrated diode were compared in a voltage fed half bridge ballast.
- 2 T8 tubes were driven by this ballast. The total output power is around 70W.
- Operation in free air without heatsinks is representative of the application.

Temperature rise



	Competitor1		Competitor2		BUJD203AX	
Vac	127V/60Hz	220V/60Hz	127V/60Hz	220V/60Hz	127V/60Hz	220V/60Hz
ΔT of Q1	34.6	26.4	25.3	18.8	24.2	18.0
ΔT of Q2	32.0	25.3	22.0	17.0	21.8	16.7

Remark:
WeEn device BUJD203A gives best performance among the three types of devices.
The temperature rise of BUJD203AX is about **10 deg C** lower than that of competitor1 and 2 deg C lower than that of competetior2.

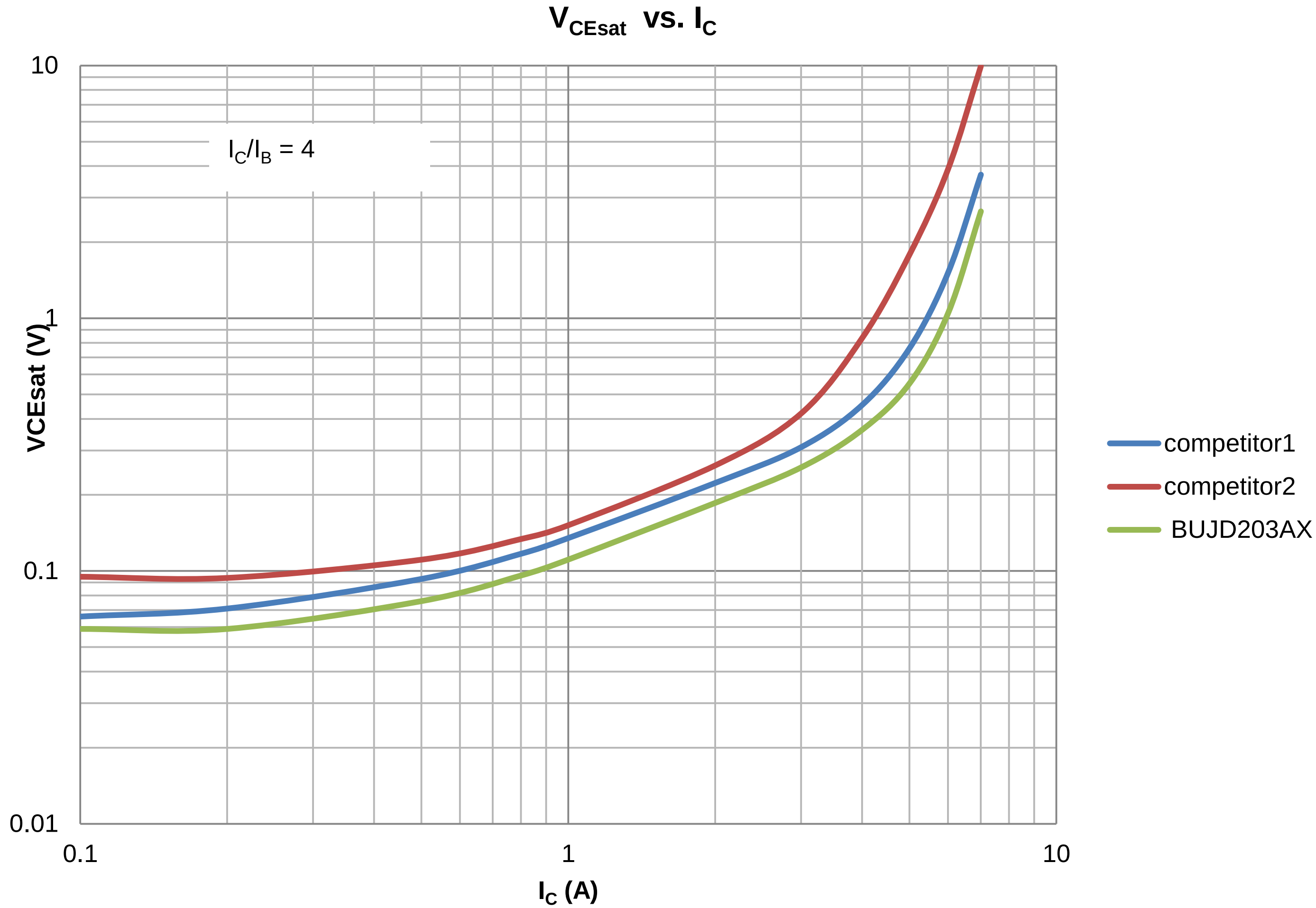
Transistor Switching

- Fast Switching
- Low Dissipation
- Low on state loss
- Low turn off loss
- Smooth turn off

Ch1: I_B
CH2: I_C
CH3: V_{BE}
CH4: V_{CE}

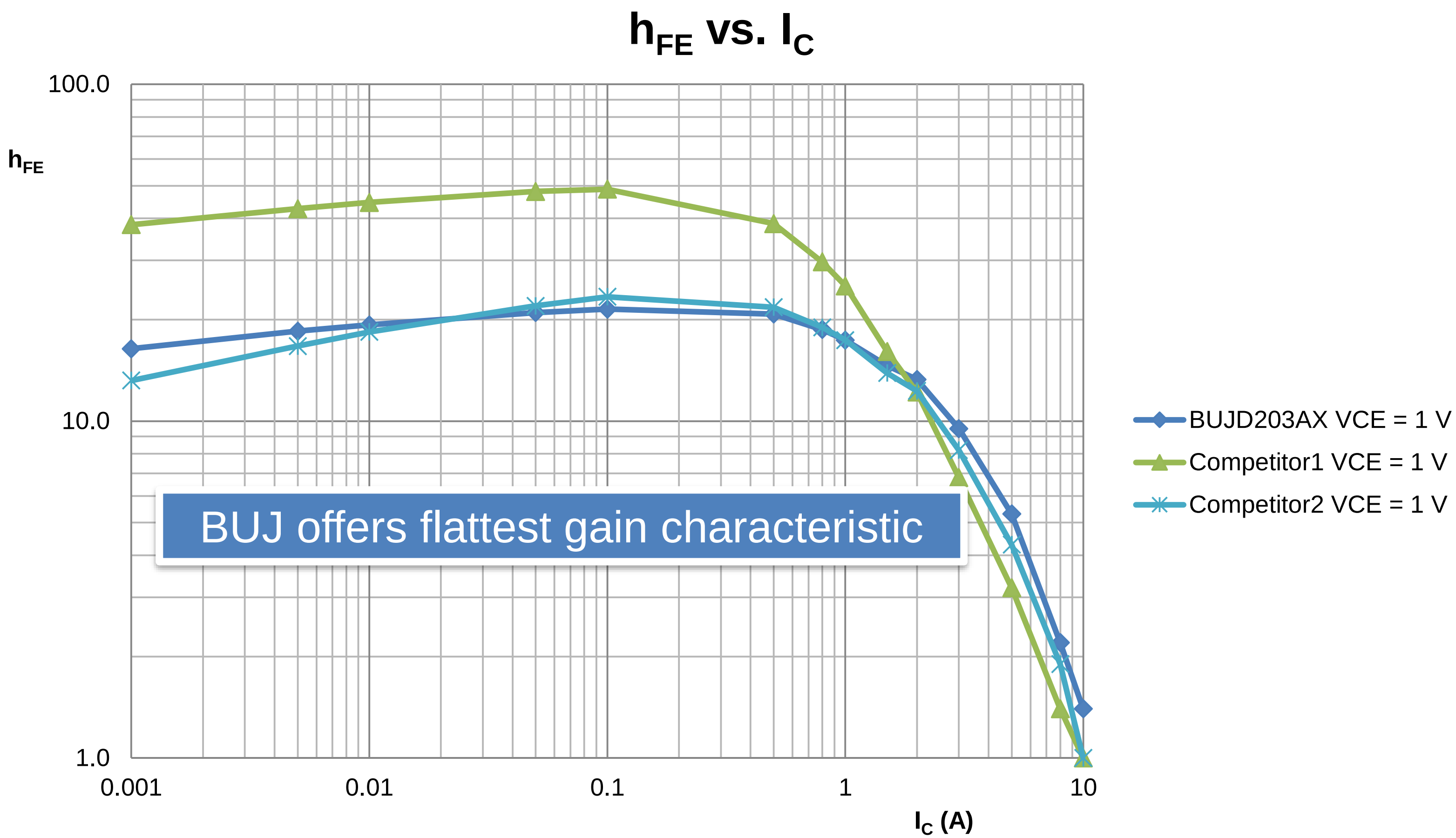
founded by NXP

Transistor Conduction



The lowest V_{CEsat} – The lowest on-state loss

Transistor Gain



Comparison of h_{FE} flatness - ease of design

Why WeEn High Voltage Transistors

- High quality planar technology for voltage blocking stability at elevated temperature -> yields long-term reliability
- Fast & smooth turn-off performance -> low switching losses
- Low saturation voltage -> low conduction losses
- Lowest overall power dissipation yields lowest temperature rise
- Tightly-controlled gain -> gain band selection not necessary
- Flat gain / current characteristic -> correct circuit operation under all conditions
- Transistor design possesses inherent avalanche ruggedness
- Assured long-term reliability

founded by NXP

WeEn

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