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January 2013

FJAFS1720
ESBC™ Rated NPN Power Transistor

ESBC Features (FDS8817 MOSFET)

$V_{CS(ON)}$	I_C	Equiv. $R_{CS(ON)}$
0.304 V	10 A	0.0304 Ω (1)

- Low Equivalent On Resistance
- Very Fast Switch: 150 kHz
- Squared RBSOA: Up to 1700 V
- Avalanche Rated
- Low Driving Capacitance, No Miller Capacitance
- Low Switching Losses
- Reliable HV Switch: No False Triggering due to High dv/dt Transients

Applications

- High-Voltage and High-Speed Power Switches
- Emitter-Switched Bipolar/MOSFET Cascode (ESBC™)
- Smart Meters, Smart Breakers, SMPS, HV Industrial Power Supplies
- Motor Drivers and Ignition Drivers

Description

The FJAFS1720 is a low-cost, high-performance power switch designed to provide the best performance when used in an ESBC™ configuration in applications such as: power supplies, motor drivers, smart grid, or ignition switches. The power switch is designed to operate up to 1700 volts and up to 12 amps, while providing exceptionally low on-resistance and very low switching losses.

The ESBC™ switch is designed to be driven using off-the-shelf power supply controllers or drivers. The ESBC™ MOSFET is a low-voltage, low-cost, surface-mount device that combines low-input capacitance and fast switching, The ESBC™ configuration further minimizes the required driving power because it does not have Miller capacitance.

The FJAFS1720 provides exceptional reliability and a large operating range due to its square reverse-bias-safe-operating-area (RBSOA) and rugged design. The device is avalanche rated and has no parasitic transistors, so is not prone to static dv/dt failures.

The power switch is manufactured using a dedicated high-voltage bipolar process and is packaged in a high-voltage TO-3PF package.

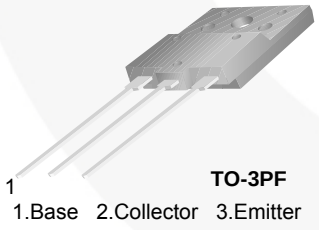

Figure 1. Pin Configuration

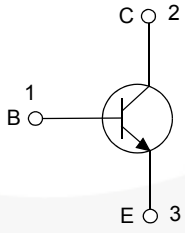

Figure 2. Internal Schematic Diagram

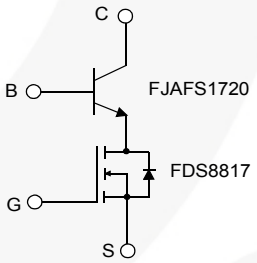

Figure 3. ESBC Configuration(2)

Ordering Information

Part Number	Marking	Package	Packing Method
FJAFS1720TU	J1720	TO-3PF	TUBE

Notes:

1. Figure of Merit.
2. Other Fairchild MOSFETs can be used in this ESBC application.

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Absolute Maximum Ratings(3)

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	1700	V
V_{CEO}	Collector-Emitter Voltage	800	V
V_{EBO}	Emitter-Base Voltage	6	V
I_C	Collector Current (DC)	12	A
P_C	Collector Dissipation (T_C = 25°C)	60	W
T_J	Operating and Junction Temperature Range	-55 to +125	°C
T_{STG}	Storage Temperature Range	-55 to +150	°C

Note:

3. Pulse Test is Pulse Width ≤ 5 ms, Duty Cycle ≤ 10%.

Thermal Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Max.	Units
$R_{\theta jC}$	Thermal Resistance, Junction to Case	2.08	°C/W

Electrical Characteristics(4)

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
I_{CES}	Collector Cut-off Current	V_{CB} = 1400 V, R_{BE} = 0			100	μA
I_{CBO}	Collector Cut-off Current	V_{CB} = 800 V, I_E = 0			10	μA
I_{EBO}	Emitter Cut-off Current	V_{EB} = 4 V, I_C = 0			100	μA
BV_{CBO}	Collector-Base Breakdown Voltage	I_C = 500 μA, I_E = 0	1700			V
BV_{CEO}	Collector-Emitter Breakdown Voltage	I_C = 5 mA, I_B = 0	800			V
BV_{EBO}	Base-Emitter Breakdown Voltage	I_E = 500 μA, I_C = 0	6			V
h_{FE1} h_{FE2}	DC Current Gain	V_{CE} = 5 V, I_C = 1 A	8.0			
		V_{CE} = 5 V, I_C = 11 A	5.5		8.5	
V_{CE}(sat)	Collector-Emitter Saturation Voltage	I_C = 10 A, I_B = 3.33 A, h_{FE} = 3		0.25		V
		I_C = 5 A, I_B = 1.0 A, h_{FE} = 5		0.20		V
		I_C = 1 A, I_B = 0.1 A, h_{FE} = 10		0.20		V
V_{BE}(sat)	Base-Emitter Saturation Voltage	I_C = 10 A, I_B = 3.33 A, h_{FE} = 3		0.86		V

Note:

4. Pulse Test: Pulse Width ≤ 5 ms, Duty Cycle ≤ 10%.

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ESBC Configured Electrical Characteristics[5]

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_T	Current Gain Bandwidth Product	I_C = 0.1 A,V_{CE} = 10 V		15		MHz
It_f	Inductive Current Fall Time	V_{GS} = 10 V, R_G = 47 Ω, V_{Clamp} = 500 V, I_C = 2 A, I_B = 0.2 A, h_{FE} = 10 L_C = 1 mH, SRF = 350 kHz		60		ns
t_s	Inductive Storage Time			1000		ns
Vt_f	Inductive Voltage Fall Time			85		ns
Vt_r	Inductive Voltage Rise Time			125		ns
t_c	Inductive Crossover Time			165		ns
It_f	Inductive Current Fall Time	V_{GS} = 10 V, R_G = 47 Ω, V_{Clamp} = 500 V, I_C = 5 A, I_B = 1 A, h_{FE} = 5 L_C = 1 mH, SRF = 350 kHz		24		ns
t_s	Inductive Storage Time			1500		ns
Vt_f	Inductive Voltage Fall Time			85		ns
Vt_r	Inductive Voltage Rise Time			65		ns
t_c	Inductive Crossover Time			110		ns
V_{CSW}	Maximum Collector Source Voltage at Turn-off without Snubber	h_{FE} = 5, I_C = 6 A	1700			V
$I_{GS(OS)}$	Gate-Source Leakage Current	V_{GS} = ±20 V		1.0		nA
$V_{CS(ON)}$	Collector-Source On Voltage	V_{GS} = 10 V, I_C = 10 A, I_B = 3.3 A, h_{FE} = 3		0.3040		V
		V_{GS} = 10 V, I_C = 6 A, I_B = 2 A, h_{FE} = 3		0.2124		V
		V_{GS} = 10 V, I_C = 3 A, I_B = 1 A, h_{FE} = 3		0.1362		V
		V_{GS} = 10 V, I_C = 3 A, I_B = 0.6 A, h_{FE} = 5		0.1662		V
$V_{GS(th)}$	Gate Threshold Voltage	V_{BS} = V_{GS}, I_B = 250 μA		1.9		V
C_{iss}	Input Capacitance (V_{GS} = V_{CB} = 0)	V_{CS} = 25 V, f = 1 MHz		1805		pF
$Q_{GS(tot)}$	Gate-Source Charge V_{CB}=0	V_{GS} = 10 V, I_C = 6 A, V_{CS} = 25 V		6		nC
$r_{DS(ON)}$	Static Drain-Source On Resistance	V_{GS} = 10 V, I_D = 15 A		5.4		mΩ
		V_{GS} = 10 V, I_D = 15 A, T_A = 125 °C		7.5		mΩ
		V_{GS} = 4.5 V, I_D = 12.6 A		7.0		mΩ

Note:

5. Used typical FDS8817 MOSFET specifications in table. Table could vary if other Fairchild MOSFETs are used.

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Typical Performance Characteristics

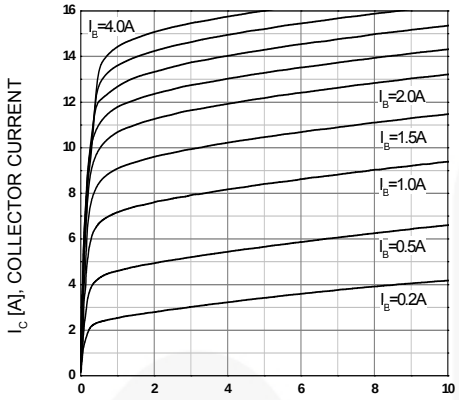

Figure 4. Static Characteristics

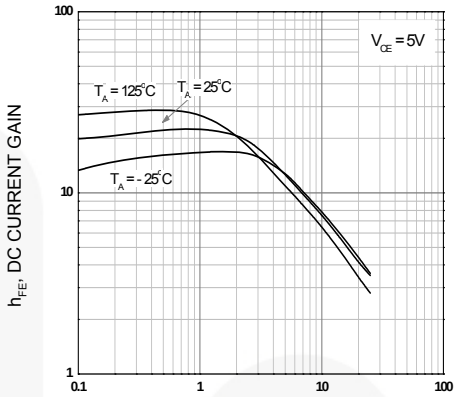

Figure 5. DC Current Gain

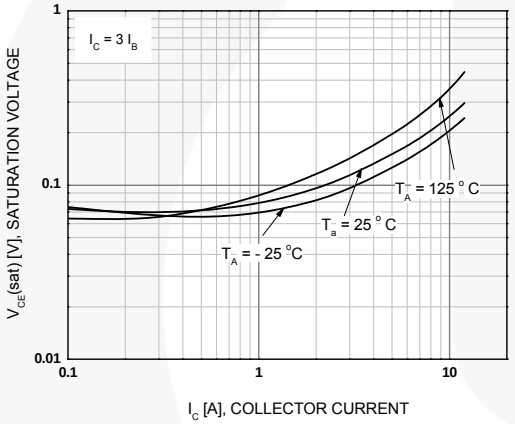

Figure 6. Collector-Emitter Saturation Voltage h_{FE}=3

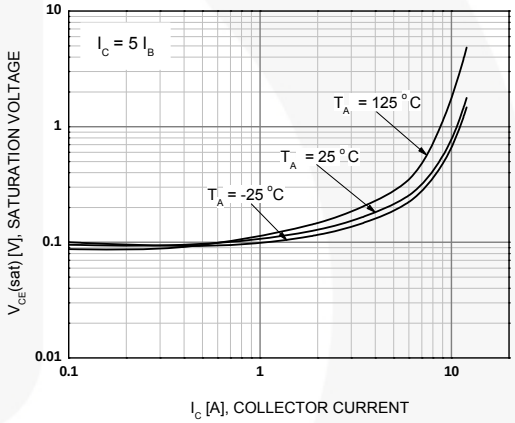

Figure 7. Collector-Emitter Saturation Voltage h_{FE}=5

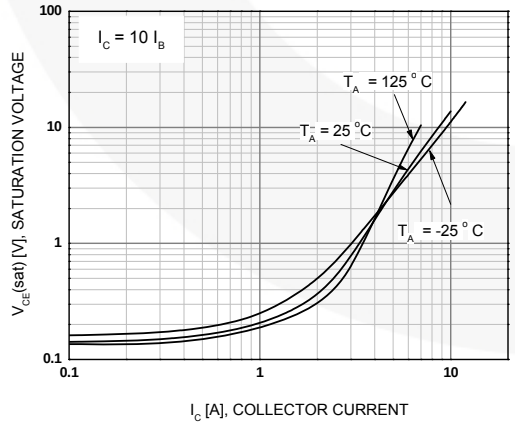

Figure 8. Collector-Emitter Saturation Voltage h_{FE}=10

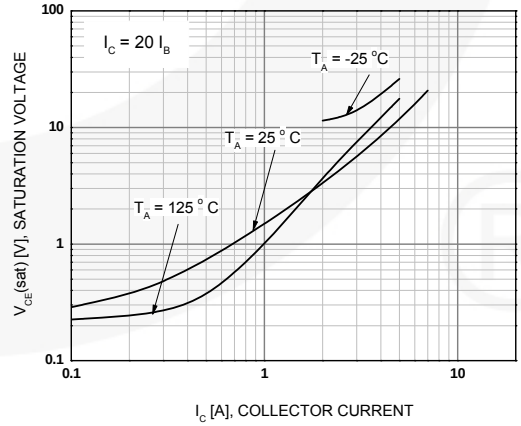

Figure 9. Collector-Emitter Saturation Voltage h_{FE}=20

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Typical Performance Characteristics (Continued)

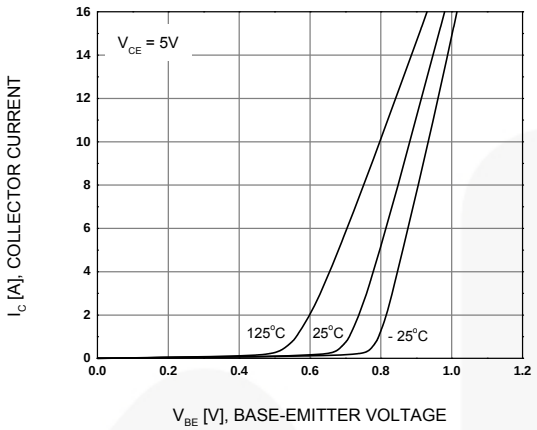

Figure 10. Base-Emitter On Voltage

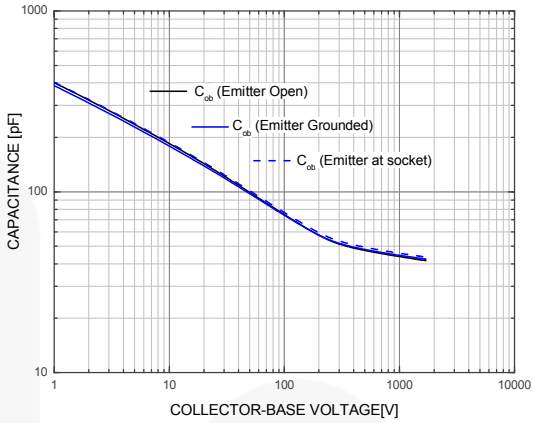

Figure 11. Capacitance

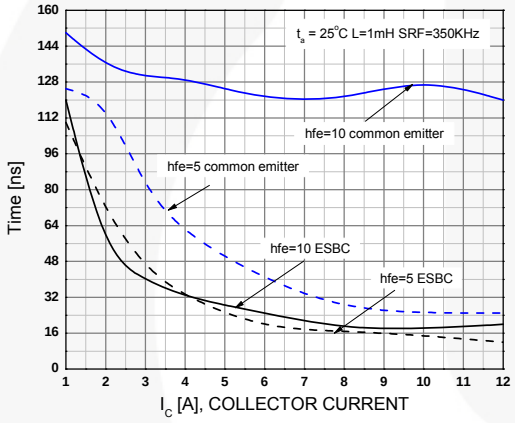

Figure 12. Inductive Load Collector Current Fall-time (t_f)

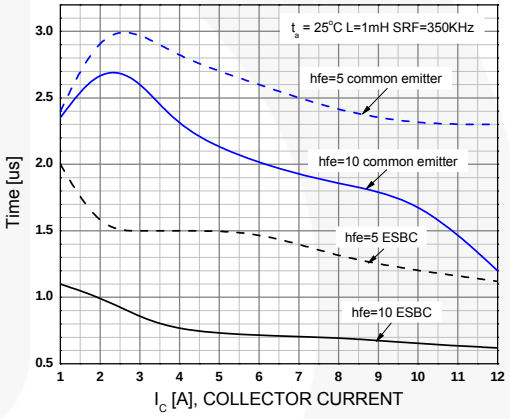

Figure 13. Inductive Load Collector Current Storage time (t_{stg})

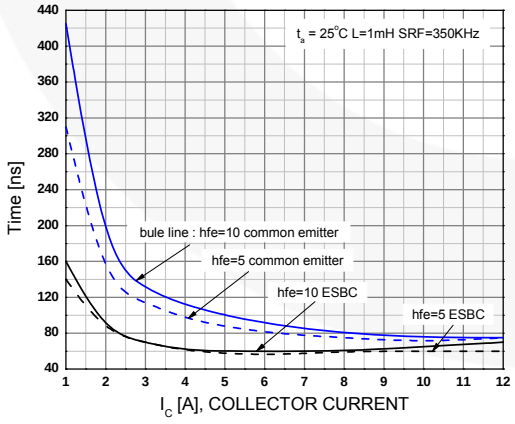

Figure 14. Inductive Load Collector Voltage Fall-time (t_f)

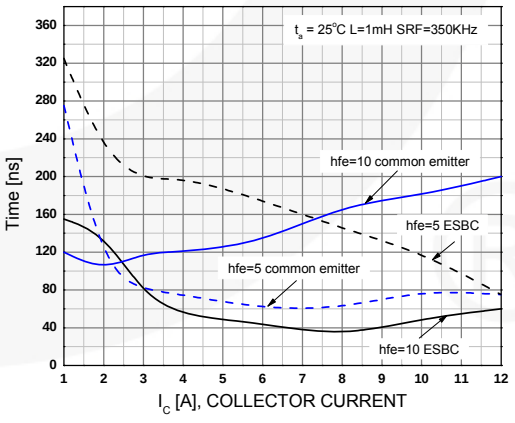

Figure 15. Inductive Load Collector Voltage Rise-time (t_r)

Typical Performance Characteristics (Continued)

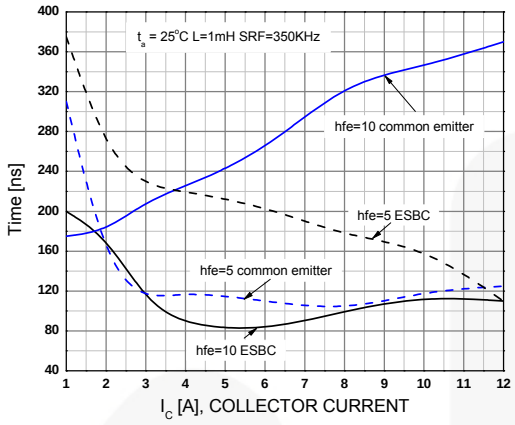

Figure 16. Inductive Load Collector Current / Voltage Crossover (t_c)

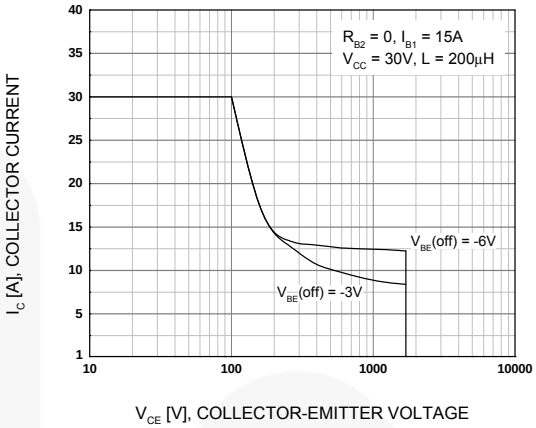

Figure 17. Reverse Bias Safe Operating Area

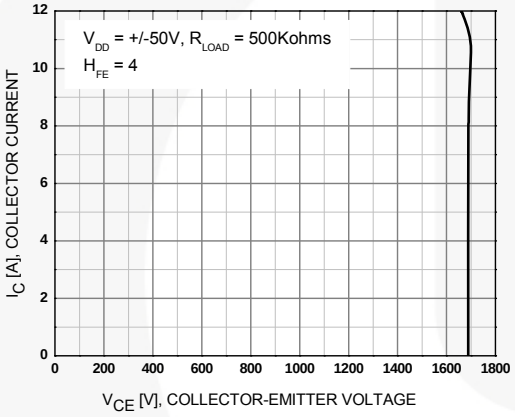

Figure 18. ESBC RBSOA

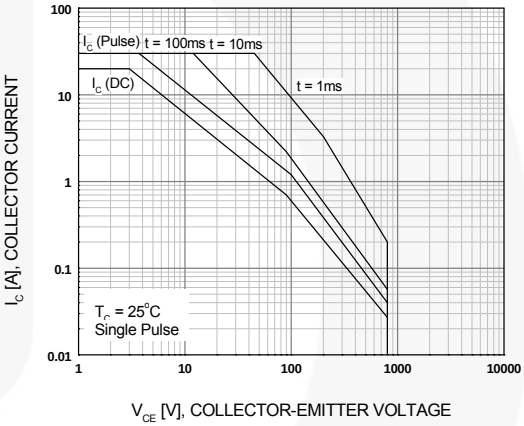

Figure 19. Forward Bias Safe Operating Area

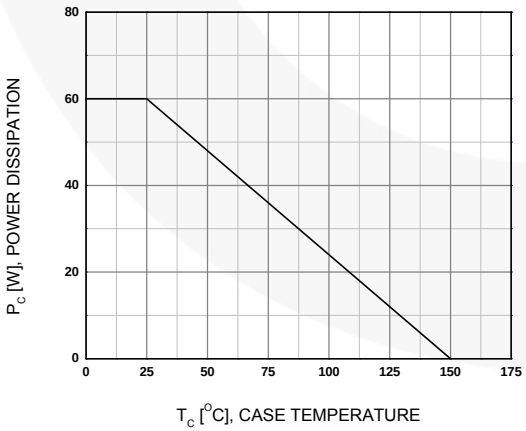

Figure 20. Power Derating

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Test Circuits

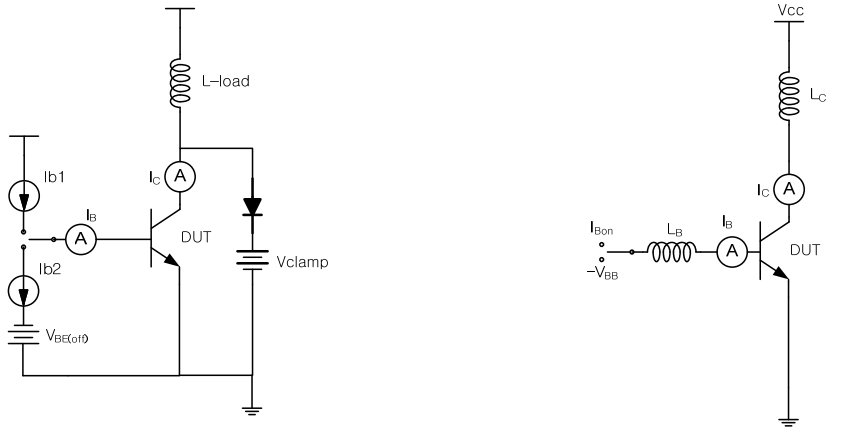

Figure 21. Test Circuit For Inductive Load and Reverse Bias Safe Operating

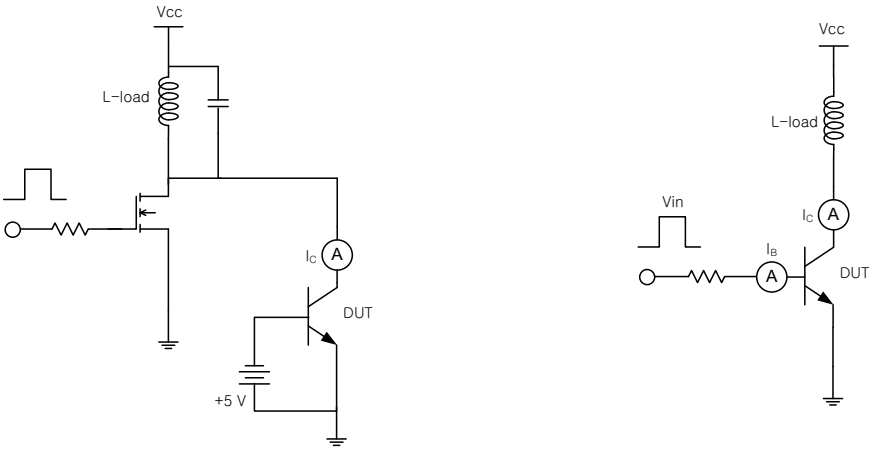

Figure 22. Energy Rating Test Circuit

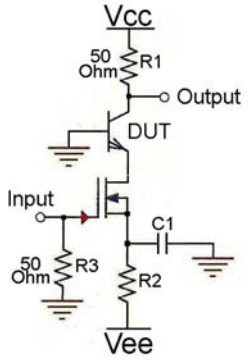

Figure 23. f_T Measurement

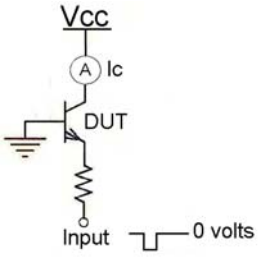

Figure 24. FBSOA

Test Circuits (Continued)

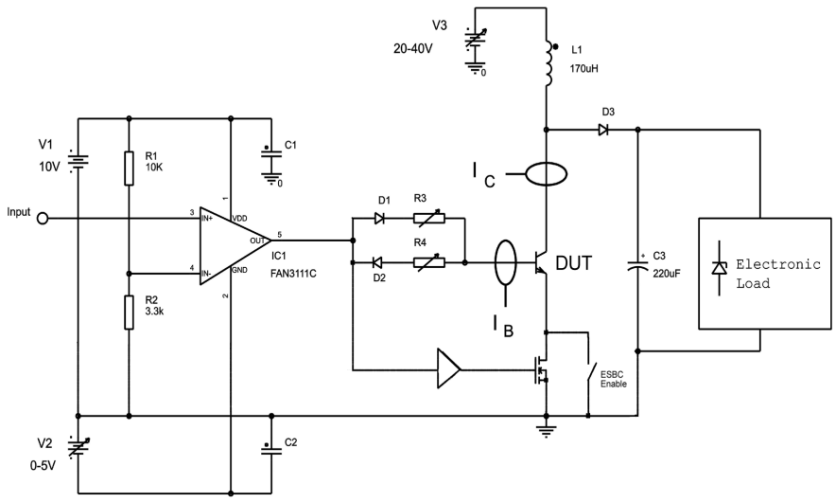

Figure 25. Simplified Saturated Switch Driver Circuit

Functional Test Waveforms

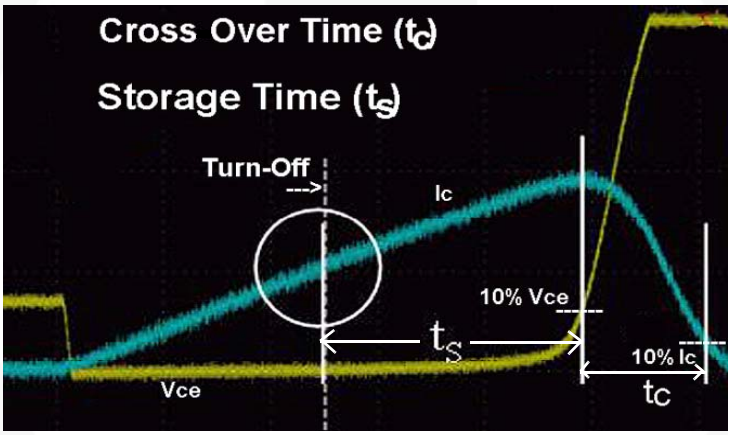

Figure 26. Crossover Time Measurement

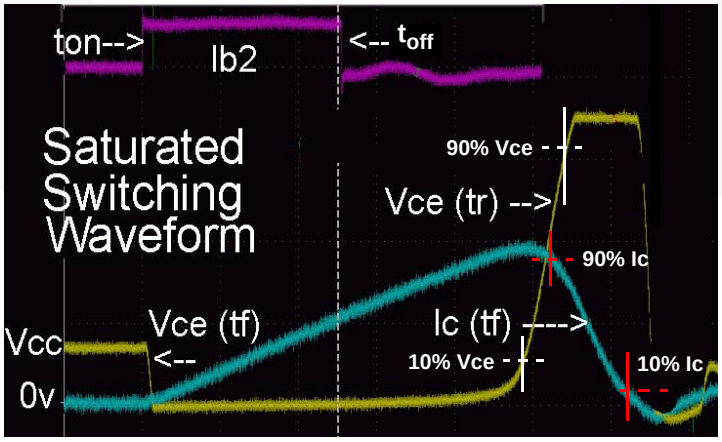

Figure 27. Saturated Switching Waveform

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Functional Test Waveforms (Continued)

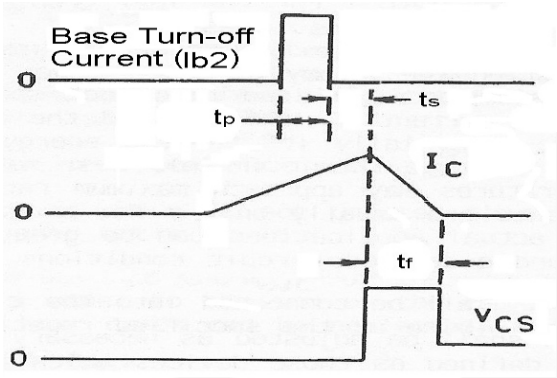


Figure 28. Storage Time - Common Emitter Base turn off (Ib2) to I_C Fall-Time

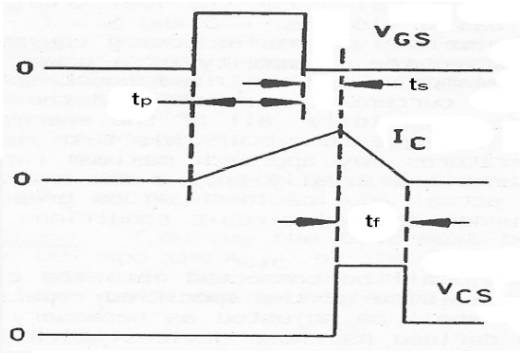
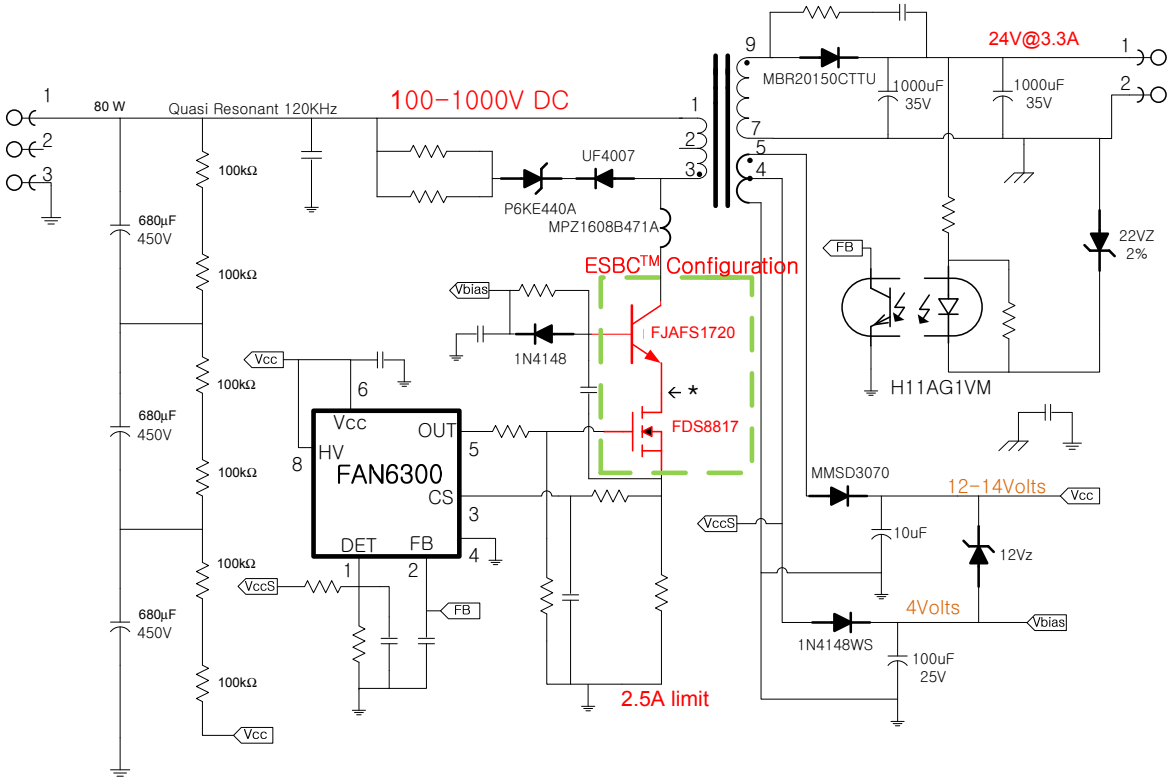


Figure 29. Storage Time - ESBC FET Gate (off) to I_C Fall-Time

Very Wide Input Voltage Range Supply

- 80 W; Secondary-Side Regulation: 3 Capacitor Input; Quasi Resonant



* Make short as possible

Driving ESBC Switches

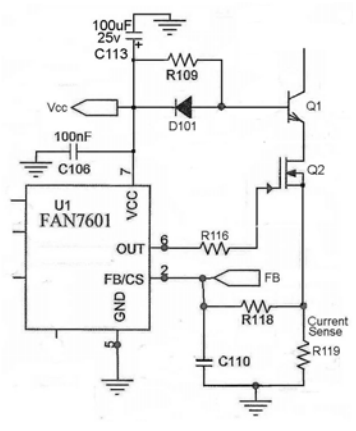


Figure30. V_{CC} Derived

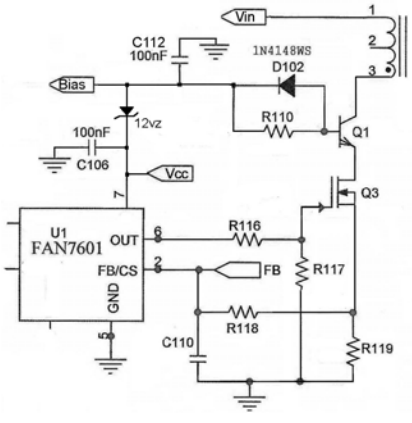


Figure31. V_{bias} Supply Derived

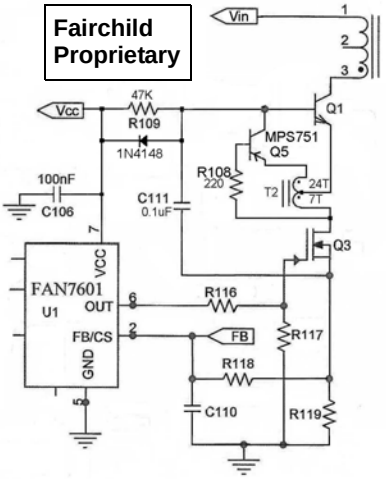


Figure32. Proportional Drive

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Physical Dimensions

TO-3PF

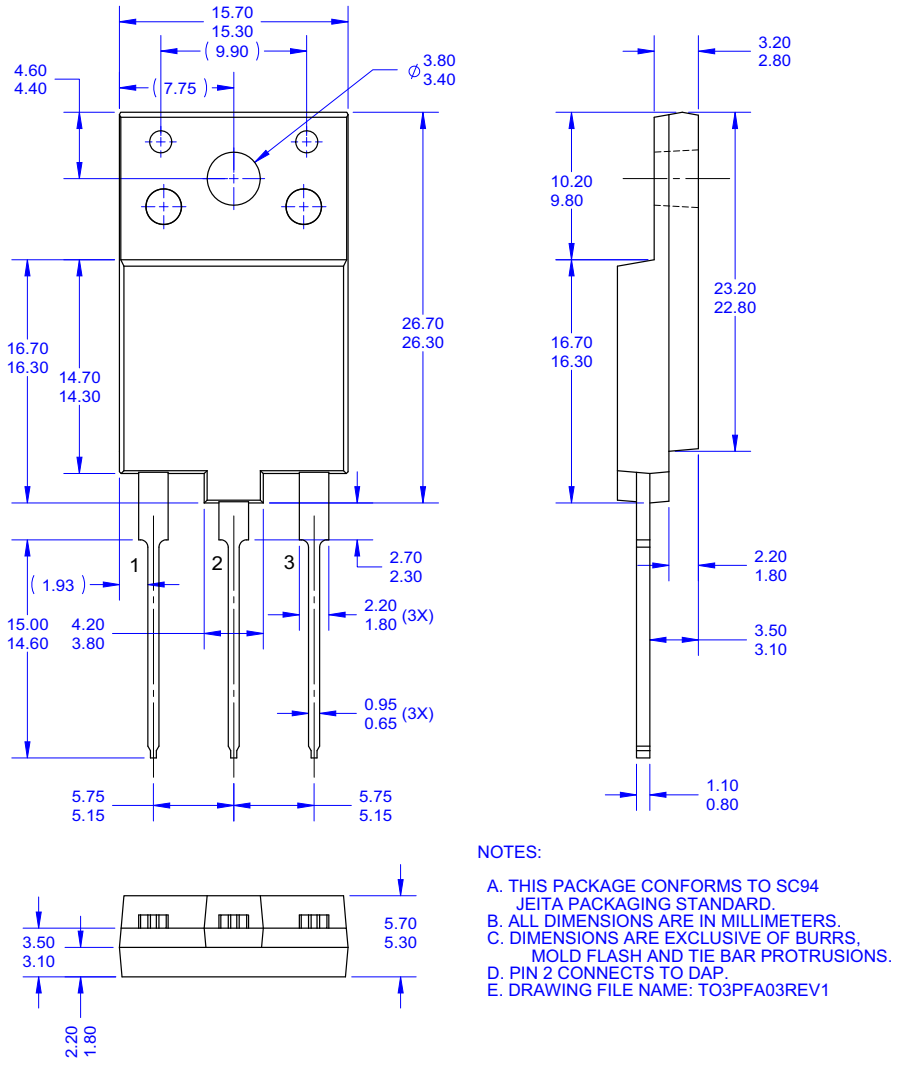

Figure 33. TO3PF, MOLDED, 3LD, FULLPACK (AG)

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