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FJAFS1510A ESBC™ Rated NPN Power Transistor

Applications

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

ESBC Features (FDC655 MOSFET)

$V_{CS(ON)}$	I_C	Equiv. $R_{CS(ON)}$
0.426 V	6 A	$0.071 \Omega^{(1)}$

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

Description

The FJAFS1510A is a low-cost, high-performance power switch designed to provide optimal 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 1550 volts and up to 6amps, 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 FJAFS1510A 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.

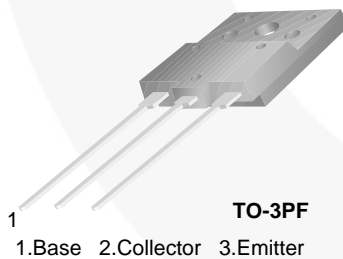


Figure 1. Pin Configuration

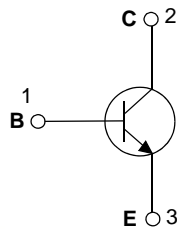


Figure 2. Internal Schematic Diagram

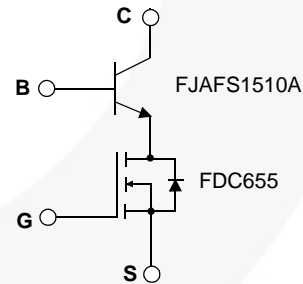


Figure 3. ESBC Configuration(2)

Ordering Information

Part Number	Marking	Package	Packing Method	Remarks
FJAFS1510ATU	J1510A	TO-3PF	TUBE	

Notes:

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

Absolute Maximum Ratings⁽³⁾

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage	1550	V
V_{CEO}	Collector-Emitter Voltage	750	V
V_{EBO}	Emitter-Base Voltage	6	V
I_C	Collector Current (DC)	6	A
P_C	Collector Dissipation ($T_C = 25^\circ\text{C}$)	60	W
T_J	Operating and Junction Temperature Range	-55 to +125	$^\circ\text{C}$
T_{STG}	Storage Temperature Range	-55 to +150	$^\circ\text{C}$

Notes:

3. Pulse Test: Pulse Width = 5 ms, Duty Cycle 10%.

Thermal Characteristics

Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Max.	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case	2.08	$^\circ\text{C}/\text{W}$

Electrical Characteristics

Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector Cut-off Current	$V_{CB} = 1400\text{ V}, R_{BE} = 0$			100	μA
I_{CBO}	Collector Cut-off Current	$V_{CB} = 800\text{ V}, I_E = 0$			10	μA
I_{EBO}	Emitter Cut-off Current	$V_{EB} = 4\text{ V}, I_C = 0$			100	μA
BV_{EBO}	Base-Emitter Breakdown Voltage	$I_E = 500\ \mu\text{A}, I_C = 0$	6			V
h_{FE1}	DC Current Gain	$V_{CE} = 5\text{ V}, I_C = 0.5\text{ A}$	15			
h_{FE2}	DC Current Gain	$V_{CE} = 5\text{ V}, I_C = 3\text{ A}$	7			
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 6\text{ A}, I_B = 1.5\text{ A}, T_A = 125^\circ\text{C}$		0.5		V
C_{ob}	Output Capacitance	$V_{CB} = 200\text{ V}, I_E = 0, f = 1\text{ MHz}$		27		pF

ESBC Configured Electrical Characteristics⁽⁴⁾Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
f_T	Current Gain Bandwidth Product	$I_C = 0.1\text{ A}, V_{CE} = 10\text{ V}$		15.4		MHz
t_{f_i}	Inductive Current Fall Time	$V_{GS} = 10\text{ V}, R_G = 47\ \Omega,$ $V_{Clamp} = 500\text{ V},$ $I_C = 1\text{ A}, I_B = 0.1\text{ A}, h_{FE} = 10,$ $L_C = 1\text{ mH},$ $SRF = 350\text{ kHz}$		115		ns
t_s	Inductive Storage Time			670		ns
V_{t_f}	Inductive Voltage Fall Time			160		ns
V_{t_r}	Inductive Voltage Rise Time			95		ns
t_c	Inductive Crossover Time			130		ns
t_{f_i}	Inductive Current Fall Time	$V_{GS} = 10\text{ V}, R_G = 47\ \Omega,$ $V_{Clamp} = 500\text{ V},$ $I_C = 5\text{ A}, I_B = 1\text{ A}, h_{FE} = 5,$ $L_C = 1\text{ mH},$ $SRF = 350\text{ kHz}$		12.5		ns
t_s	Inductive Storage Time			1100		ns
V_{t_f}	Inductive Voltage Fall Time			68		ns
V_{t_r}	Inductive Voltage Rise Time			110		ns
t_c	Inductive Crossover Time			150		ns
V_{CSW}	Maximum Collector Source Voltage at Turn-off without Snubber	$h_{FE} = 5, I_C = 6\text{ A}$	1550			V
$I_{GS(OS)}$	Gate-Source Leakage Current	$V_{GS} = \pm 20\text{ V}$		1.0		nA
$V_{CS(ON)}$	Collector-Source On Voltage	$V_{GS} = 10\text{ V}, I_C = 6\text{ A}, I_B = 2\text{ A}, h_{FE} = 3$		0.426		V
		$V_{GS} = 10\text{ V}, I_C = 4\text{ A}, I_B = 1.3\text{ A}, h_{FE} = 3$		0.213		V
		$V_{GS} = 10\text{ V}, I_C = 2\text{ A}, I_B = 0.67\text{ A}, h_{FE} = 3$		0.162		V
		$V_{GS} = 10\text{ V}, I_C = 1\text{ A}, I_B = 0.2\text{ A}, h_{FE} = 5$		0.141		V
$V_{GS(th)}$	Gate Threshold Voltage	$V_{BS} = V_{GS}, I_B = 250\ \mu\text{A}$		1.9		V
C_{iss}	Input Capacitance ($V_{GS} = V_{CB} = 0$)	$V_{CS} = 25\text{ V}, f = 1\text{ MHz}$		470		pF
$Q_{GS(tot)}$	Gate-Source Charge $V_{CB} = 0$	$V_{GS} = 10\text{ V}, I_C = 6\text{ A}, V_{CS} = 25\text{ V}$		9		nC
$r_{DS(ON)}$	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}, I_D = 6.3\text{ A}$		21		m Ω
		$V_{GS} = 10\text{ V}, I_D = 6.3\text{ A}, T_A = 125^\circ\text{C}$		30		m Ω
		$V_{GS} = 4.5\text{ V}, I_D = 5.5\text{ A}$		26		m Ω

Notes:

4. Used typical FDC655 MOSFET specifications in table. Table could vary if other Fairchild MOSFETs are used.

Typical Performance Characteristics

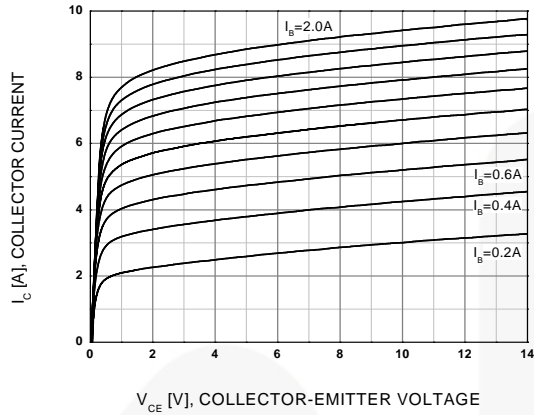


Figure 4. Static Characteristic

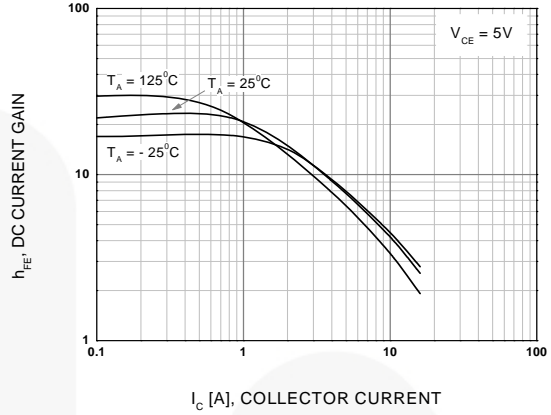
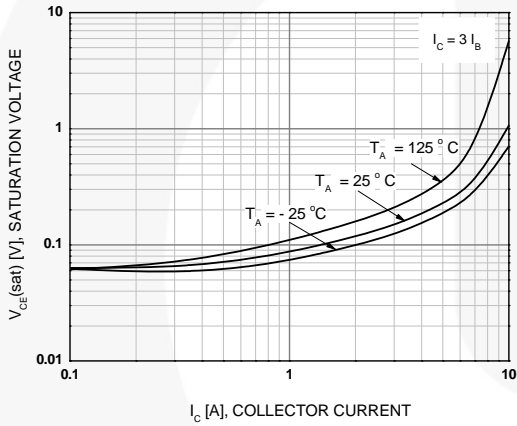
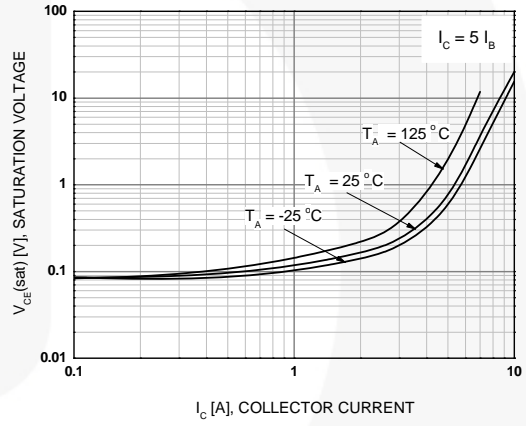


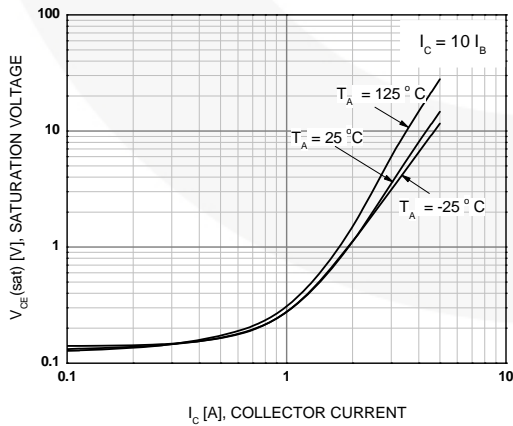
Figure 5. DC current Gain



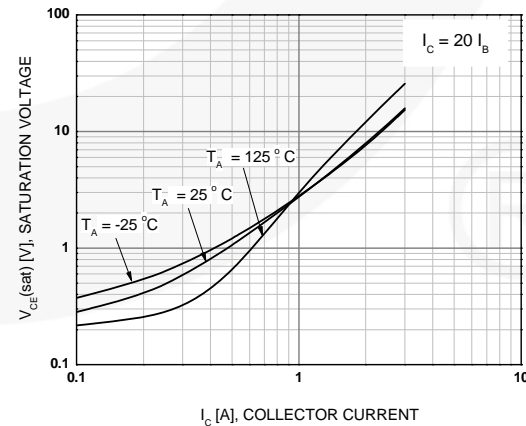
**Figure 6. Collector-Emitter Saturation Voltage
 $h_{FE}=3$**



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



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



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

Typical Performance Characteristics (Continued)

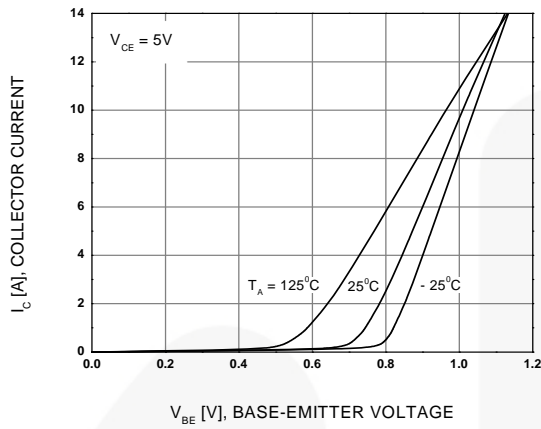


Figure 10. Base-Emitter On Voltage

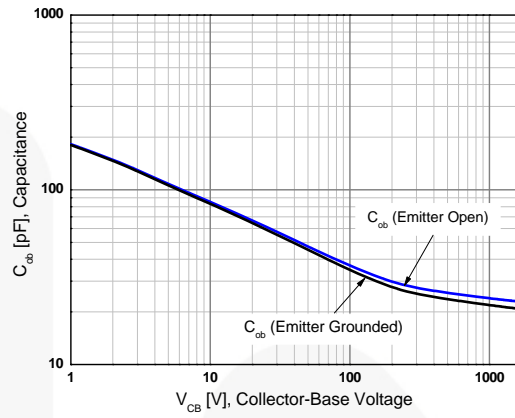


Figure 11. Capacitance

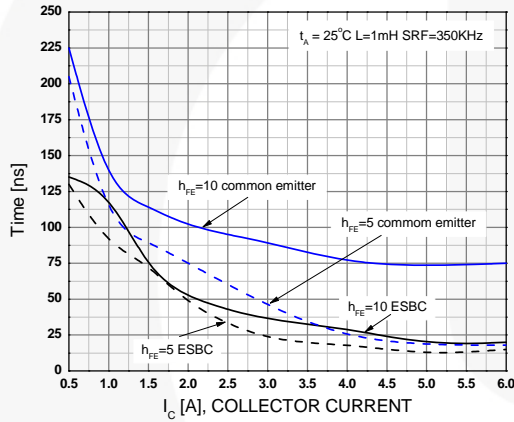


Figure 12. Inductive Load Collector Current Fall-time (t_r)

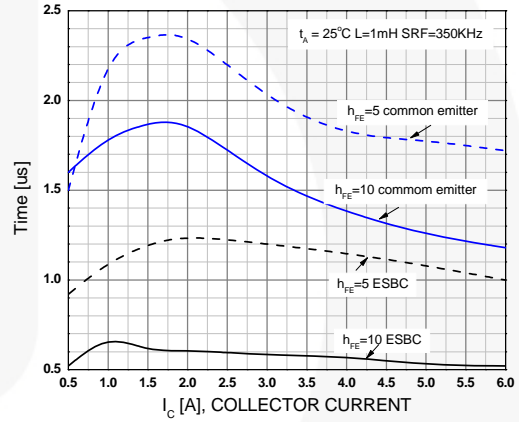


Figure 13. Inductive Load Collector Current Storage time (t_{stg})

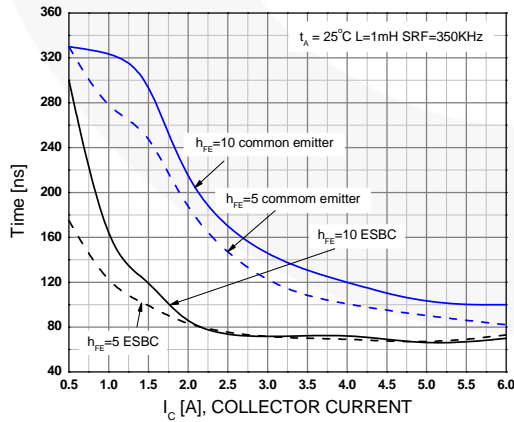


Figure 14. Inductive Load Collector Voltage Fall-time (t_r)

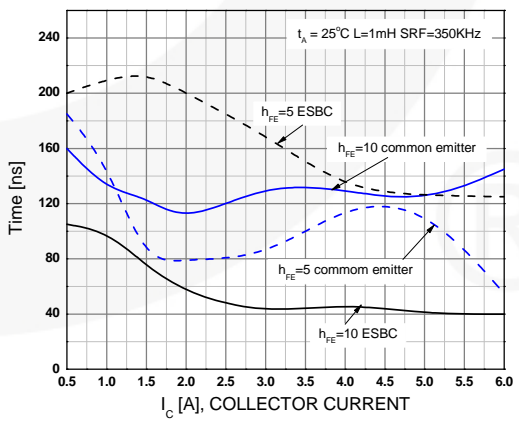


Figure 15. Inductive Load Collector Voltage Rise-time (t_r)

Typical Performance Characteristics (Continued)

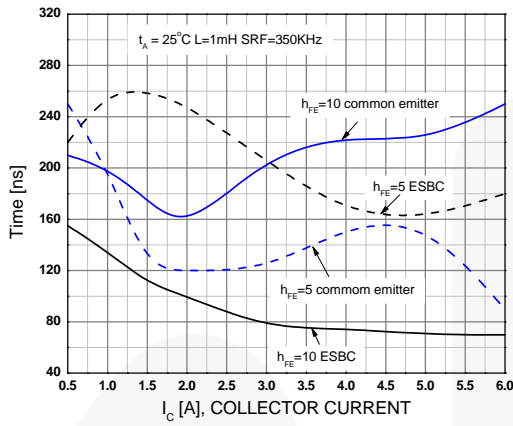


Figure 16. Inductive Load Collector Current/Voltage Crossover (t_c)

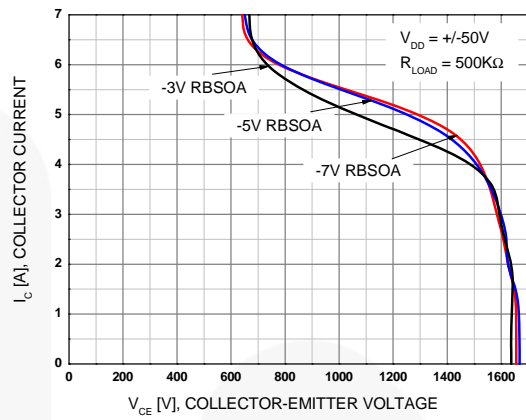


Figure 17. Reverse Bias Safe Operating Area

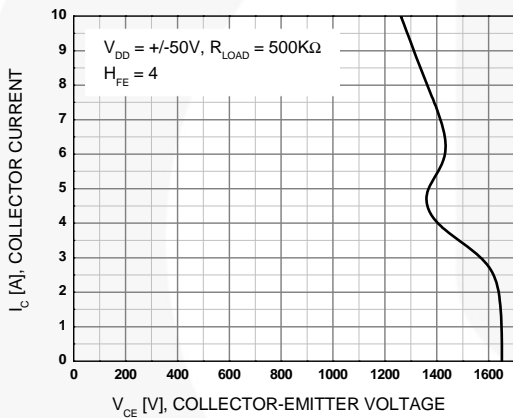


Figure 18. ESBC RBSOA

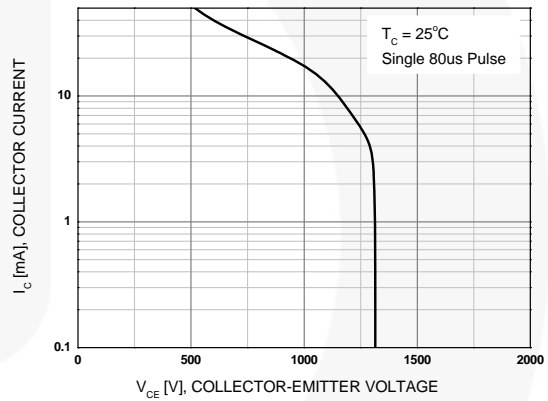


Figure 19. Forward Bias Safe Operating Area

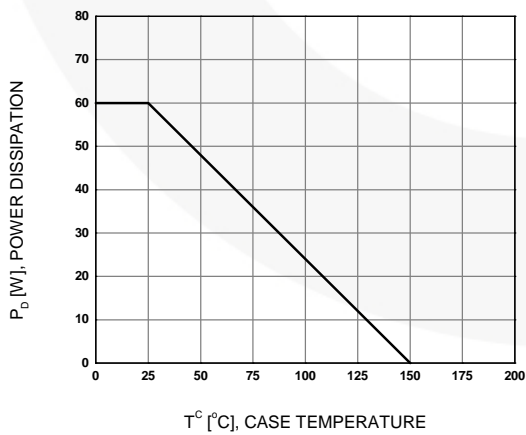


Figure 20. Power Derating

Test Circuits

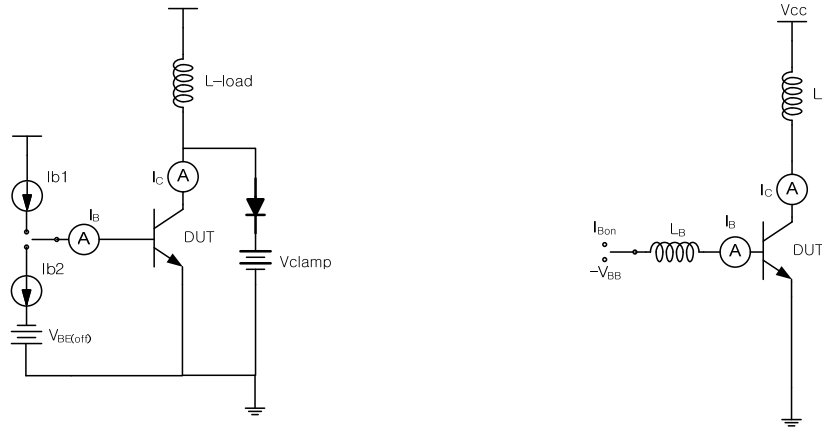


Figure 21. Test Circuit For Inductive Load and Reverse Bias Safe Operating

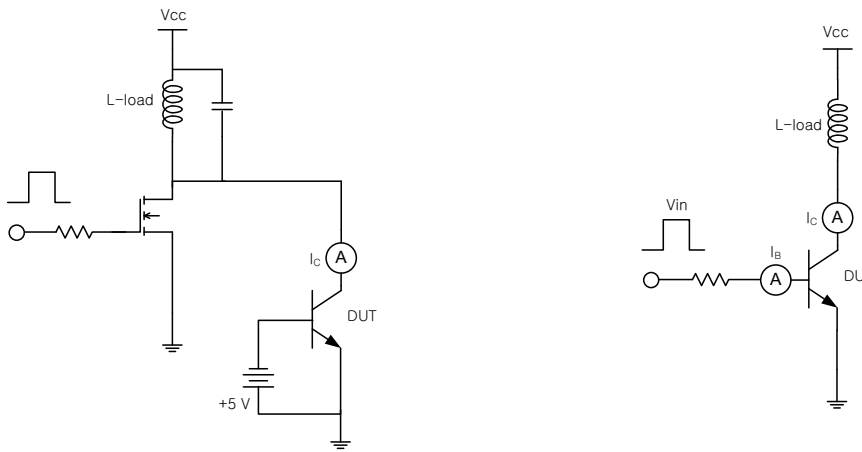


Figure 22. Energy Rating Test Circuit

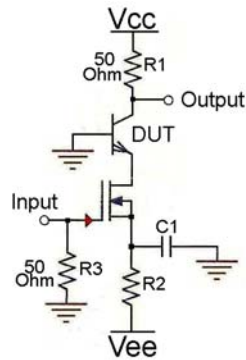


Figure 23. Ft Measurement

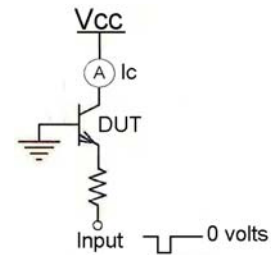


Figure 24. FBSOA

Test Circuits (Continued)

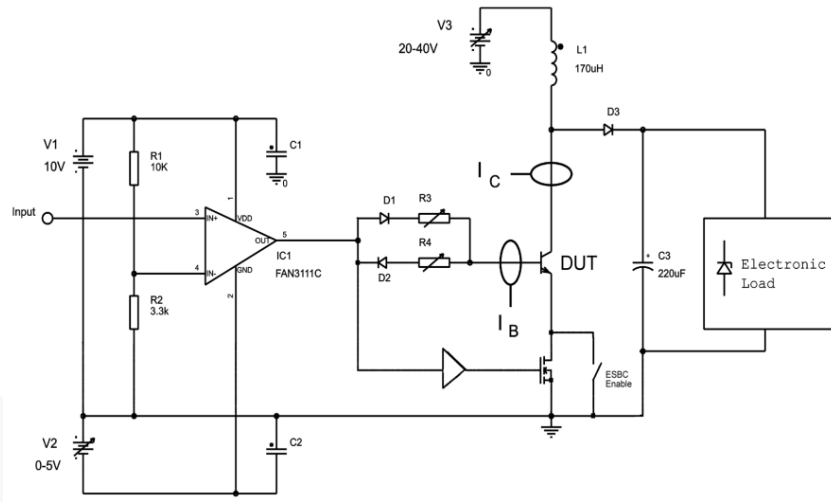


Figure 25. Simplified Saturated Switch Driver Circuit

Functional Test Waveforms

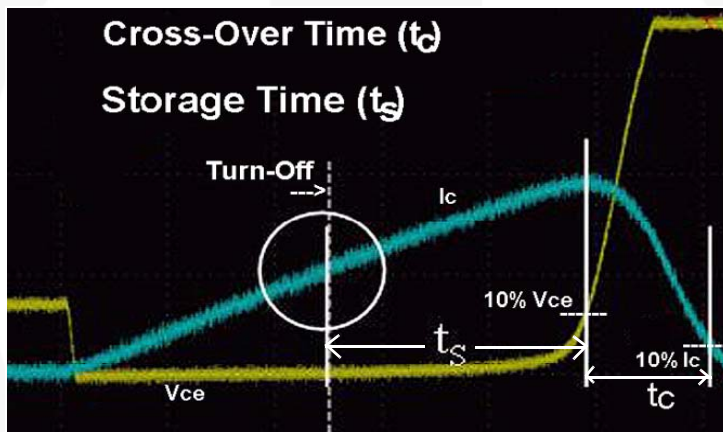


Figure 26. Crossover Time Measurement

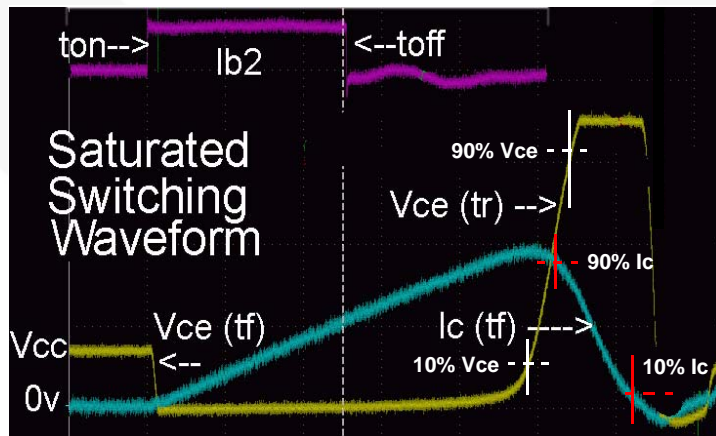


Figure 27. Saturated Switching Waveform

Functional Test Waveforms (Continued)

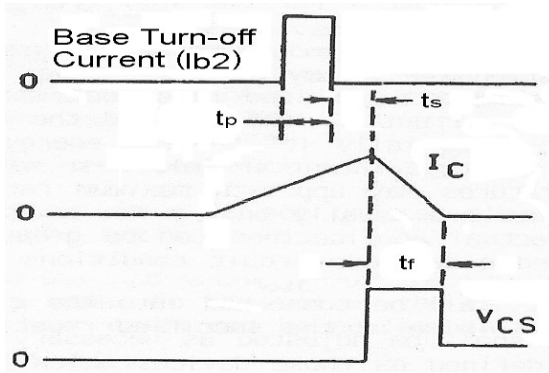


Figure 28. Storage Time - Common Emitter
Base turn off (I_{b2}) to I_C Fall-time

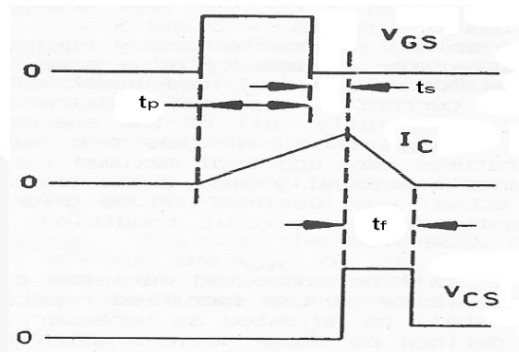
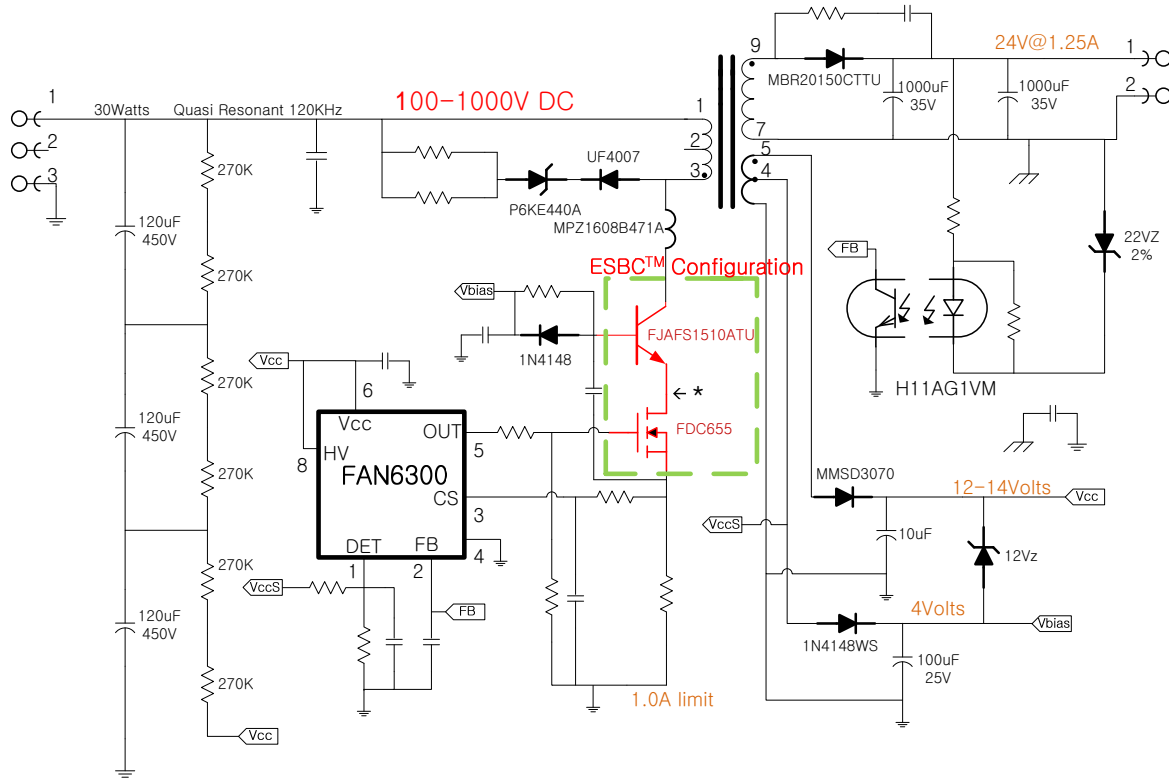


Figure 29. Storage Time - ESBC FET
Gate (off) to I_C Fall-time



Very Wide Input Voltage Range Supply

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



* Make short as possible

Figure 30. Very Wide Input Voltage Range Supply

Driving ESBC Switches

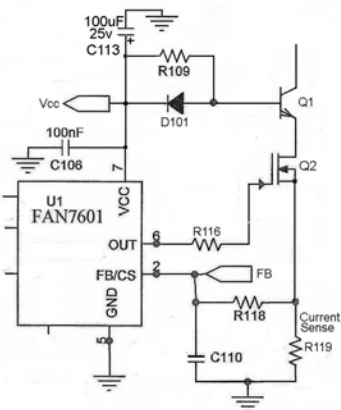


Figure 31. V_{CC} Derived

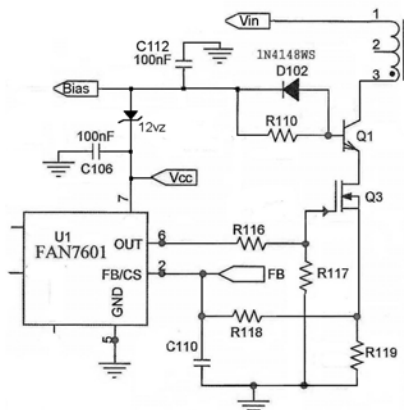


Figure 32. V_{BIAS} Supply Derived

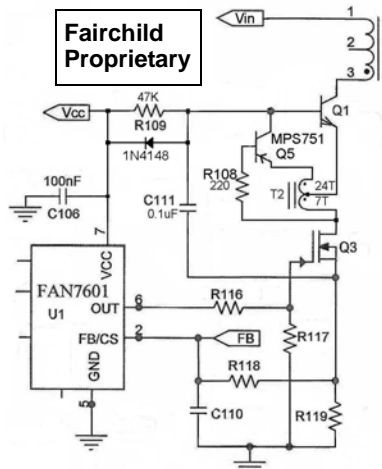


Figure 33. Proportional Drive

Physical Dimensions

TO-3PF

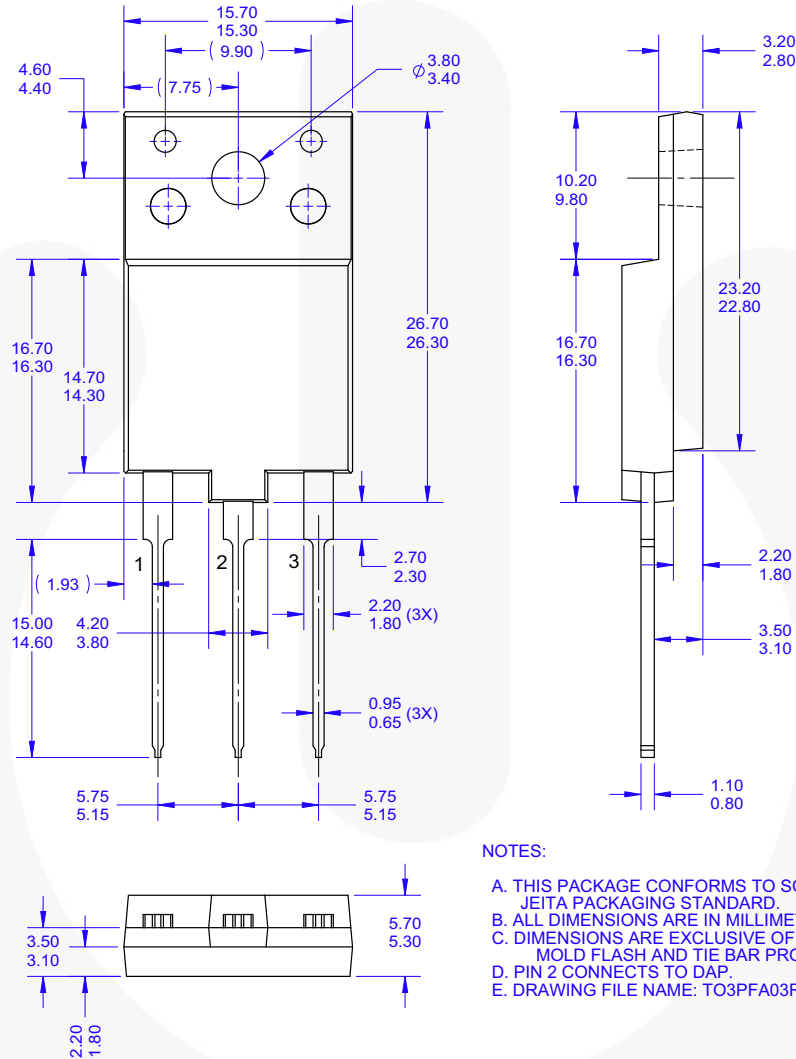


Figure 34. TO-3PF, 3 Leads, Molded, Full Pack

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| Build it Now™ | Green FPS™ | QS™ | TinyCalc™ |
| CorePLUS™ | Green FPS™ e-Series™ | Quiet Series™ | TinyLogic® |
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