FAIRCHILD SEMICONDUCTOR®

April 2013

FJPF2145
ESBC™ Rated NPN Power Transistor

ESBC Features (FDC655 MOSFET)

$V_{CS(ON)}$	I_C	Equiv. $R_{CS(ON)}$ [1]
0.21 V	2 A	0.105 Ω

- Low Equivalent On Resistance
- Very Fast Switch: 150 kHz
- Wide RBSOA: Up to 1100 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, High-Speed Power Switches
- Emitter-Switched Bipolar/MOSFET Cascode (ESBC™)
- Smart Meters, Smart Breakers, SMPS, HV Industrial Power Supplies
- Motor Drivers and Ignition Drivers

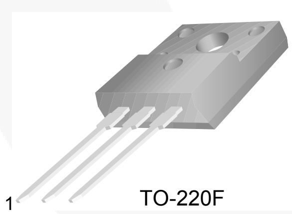
Description

The FJPF2145 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 1100 volts and up to 5 amps, while providing exceptionally low on-resistance and very low switching losses.

The ESBC™ switch can 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 FJPF2145 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-220F package.



1.Base 2.Collector 3.Emitter

Figure 1. Pin Configuration

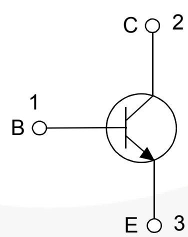


Figure 2. Internal Schematic Diagram

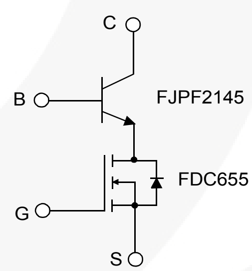


Figure 3. ESBC Configuration[2]

Ordering Information

Part Number	Marking	Package	Packing Method
FJPF2145TU	J2145	TO-220F	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°C unless otherwise noted..

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	1100	V
V_{CEO}	Collector-Emitter Voltage	800	V
V_{EBO}	Emitter-Base Voltage	7	V
I_C	Collector Current (DC)	5	A
I_B	Base Current	1.5	A
P_C	Collector Dissipation (T_C = 25°C)	40	W
T_J	Operating and Junction Temperature Range	-55 to +125	°C
T_{STG}	Storage Temperature Range	-55 to +150	°C
EAR[4]	Avalanche Energy (T_J = 25°C, 1.2 mH)	15	mJ

Notes:

3. Pulse test is pulse width ≤ 5 ms, duty cycle ≤ 10%.

4. Lab characterization data only for reference.

Thermal Characteristics

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

Symbol	Parameter	Max.	Units
$R_{\theta jc}$	Thermal Resistance, Junction to Case	3.125	°C/W
$R_{\theta ja}$	Thermal Resistance, Junction to Ambient	70.44	°C/W

Electrical Characteristics[5]

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
BV_{CBO}	Collector-Base Breakdown Voltage	I_C = 1 mA, I_E = 0	1100			V
BV_{CEO}	Collector-Emitter Breakdown Voltage	I_C = 5 mA, I_B = 0	800			V
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 1 mA, I_C = 0	7			V
I_{CBO}	Collector Cut-off Current	V_{CB} = 800 V, I_E = 0			10	µA
I_{EBO}	Emitter Cut-off Current	V_{EB} = 5 V, I_C = 0			10	µA
h_{FE1}	DC Current Gain	V_{CE} = 5 V, I_C = 0.2 A	20		40	
h_{FE2}		V_{CE} = 5 V, I_C = 1 A	8			
$V_{CE}(sat)$	Collector-Emitter Saturation Voltage	I_C = 0.25 A, I_B = 0.05 A		0.051		V
		I_C = 0.5 A, I_B = 0.167 A		0.055		V
		I_C = 1 A, I_B = 0.33 A		0.085		V
		I_C = 1.5 A, I_B = 0.3 A		0.159	2.000	V
$V_{BE}(sat)$	Base-Emitter Saturation Voltage	I_C = 500 mA, I_B = 50 mA		0.756		V
		I_C = 1.5 A, I_B = 0.3 A		0.840	1.500	V
		I_C = 2 A, I_B = 0.4 A		0.863		V
C_{IB}	Input Capacitance	V_{EB} = 5 V, I_C = 0, f = 1 MHz		1.618		pF
C_{OB}	Output Capacitance	V_{CB} = 200 V, I_E = 0, f = 1 MHz		11.39		pF
f_T	Current Gain Bandwidth Product	V_{CE} = 10 V, I_C = 0.2 A		15		MHz

Note:

5. Pulse test is pulse width ≤ 5 ms, duty cycle ≤ 10%.

ESBC-Configured Electrical Characteristics[6]

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
f_T	Current Gain Bandwidth Product	I_C = 0.1 A, V_{CE} = 10 V		28.40		MHz
It_f	Inductive Current Fall Time	V_{CC} = 100 V, V_{GS} = 10 V, R_G = 4 7Ω, V_{Clamp} = 500 V, I_C = 0.5 A, I_B = 0.05 A, H_{FE} = 10, L_C = 166 μH, SRF = 684 kHz		95		ns
t_s	Inductive Storage Time			0.13		ns
Vt_f	Inductive Voltage Fall Time			135		ns
Vt_r	Inductive Voltage Rise Time			80		ns
t_c	Inductive Crossover Time			115		ns
It_f	Inductive Current Fall Time	V_{CC} = 100 V, V_{GS} = 10 V, R_G = 47 Ω, V_{Clamp} = 500 V, I_C = 1 A, I_B = 0.2 A, H_{FE} = 5, L_C = 166 μH, SRF = 684 kHz		50		ns
t_s	Inductive Storage Time			0.34		ns
Vt_f	Inductive Voltage Fall Time			150		ns
Vt_r	Inductive Voltage Rise Time			60		ns
t_c	Inductive Crossover Time			95		ns
V_{CSW}	Maximum Collector-Source Voltage at Turn-off without Snubber	h_{FE} = 5, I_C = 2 A	1100			V
$I_{GS(OS)}$	Gate-Source Leakage Current	V_{GS} = ±20 V		1		nA
$V_{CS(ON)}$	Collector-Source On Voltage	V_{GS} = 10 V, I_C =2 A, I_B = 0.67 A, h_{FE} = 3		0.209		V
		V_{GS} = 10 V, I_C = 1 A, I_B = 0.33 A, h_{FE} = 3		0.114		V
		V_{GS} = 10 V, I_C = 0.5 A,I_B = 0.17 A, h_{FE} = 3		0.068		V
		V_{GS} = 10 V, I_C = 0.3 A, I_B = 0.06 A, h_{FE} = 5		0.062		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		470		pF
$Q_{GS(tot)}$	Gate-Source Change V_{CB} = 0	V_{GS} = 10 V, I_C = 6.3 A, V_{CS} = 25 V		9		nC
$R_{DS(ON)}$	Static Drain-to-Source On Resistance	V_{GS} = 10 V, I_D = 6.3 A		21		mΩ
		V_{GS} = 4.5 V, I_D = 5.5 A		26		mΩ
		V_{GS} = 10 V, I_D = 6.3 A, T_J = 125°C		30		mΩ

Note:

6. A typical FDC655 MOSFET was used for the specifications above. Values could vary if other Fairchild MOSFETs are used.

Typical Performance Characteristics

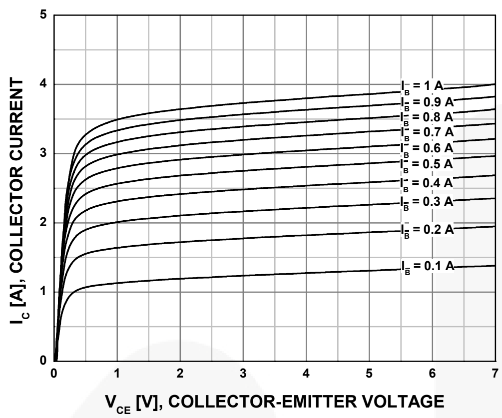


Figure 4. Static Characteristics

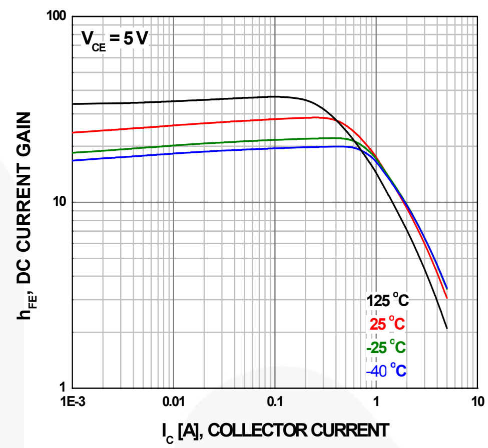


Figure 5. DC Current Gain

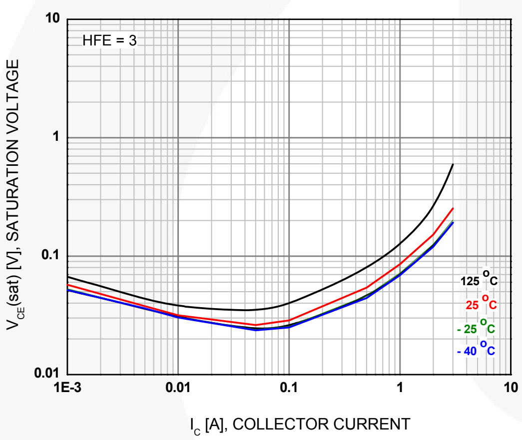


Figure 6. Collector-Emitter Saturation Voltage h_{FE} = 3

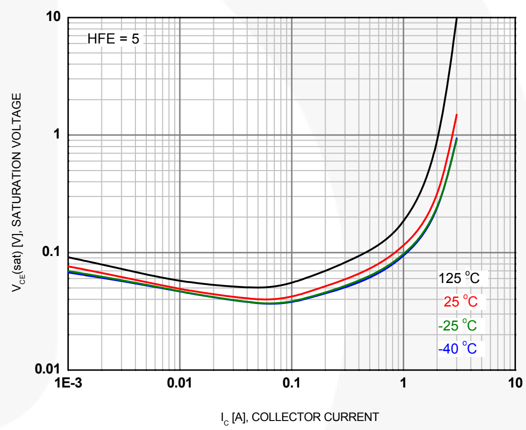


Figure 7. Collector-Emitter Saturation Voltage h_{FE} = 5

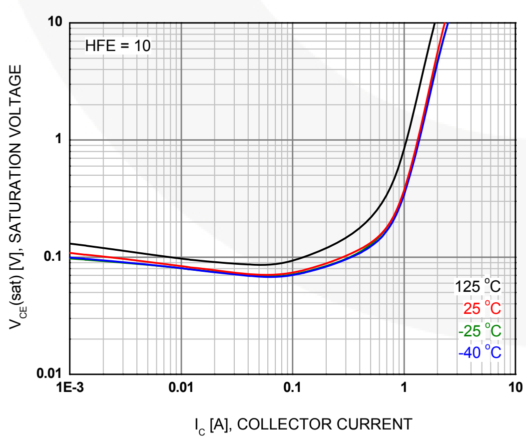


Figure 8. Collector-Emitter Saturation Voltage h_{FE} = 10

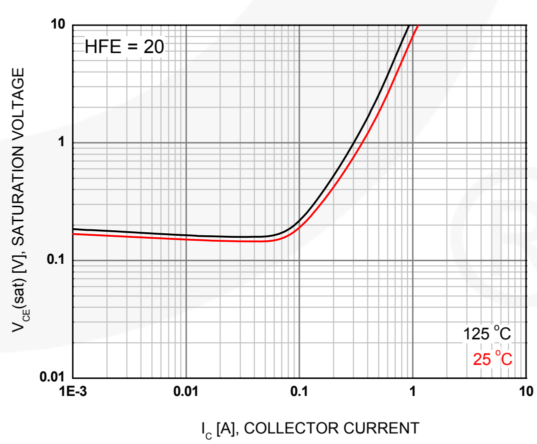


Figure 9. Collector-Emitter Saturation Voltage h_{FE} = 20

Typical Performance Characteristics (Continued)

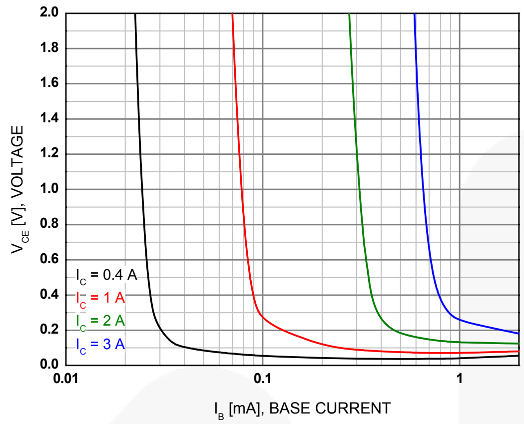


Figure 10. Typical Collector Saturation Voltage

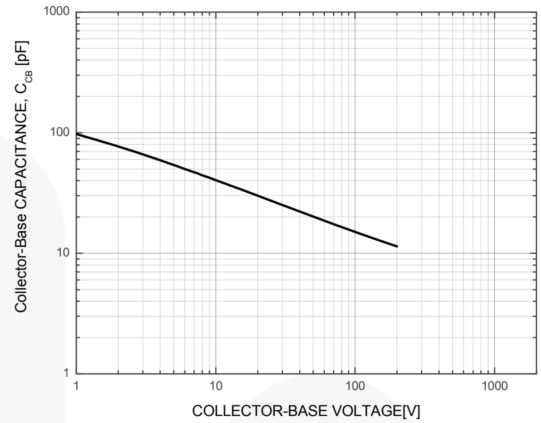


Figure 11. Capacitance

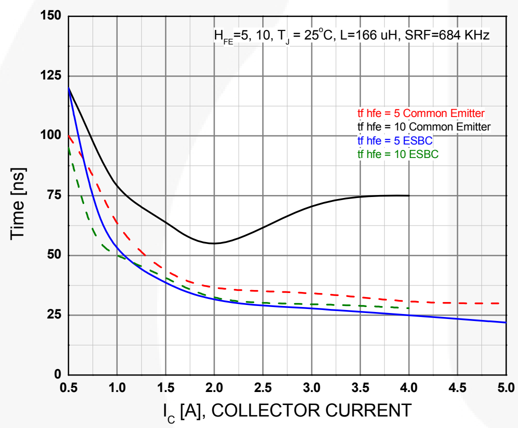


Figure 12. Inductive Load Collector Current Fall - Time (t_f)

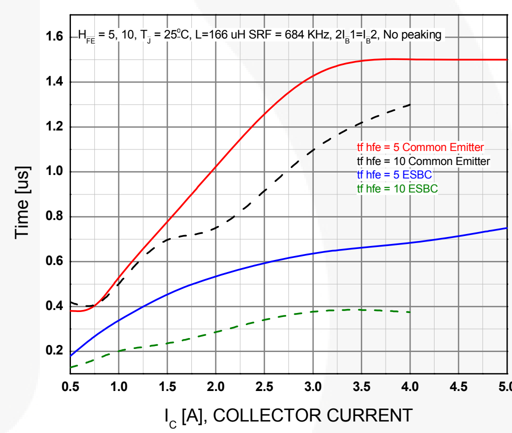


Figure 13. Inductive Load Collector Current Storage - Time (t_{stg})

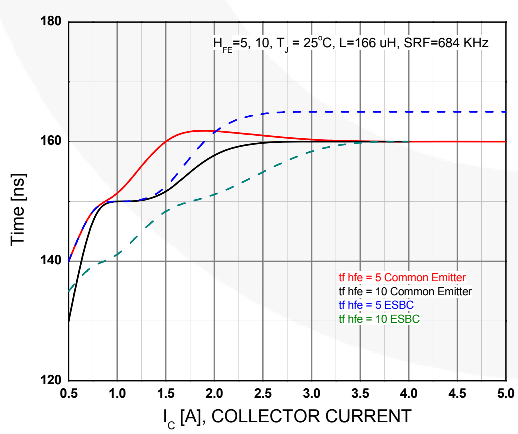


Figure 14. Inductive Load Collector Voltage Fall - Time (t_f)

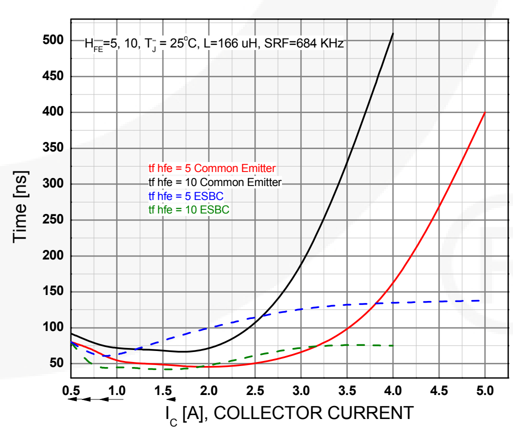


Figure 15. Inductive Load Collector Voltage Rise - Time (t_r)

Typical Performance Characteristics (Continued)

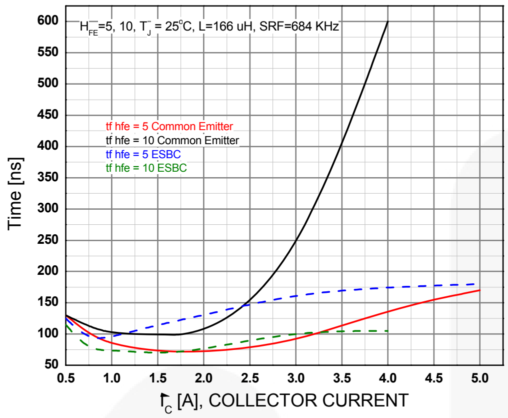


Figure 16. Inductive Load Collector Current / Voltage Crossover (t_c)

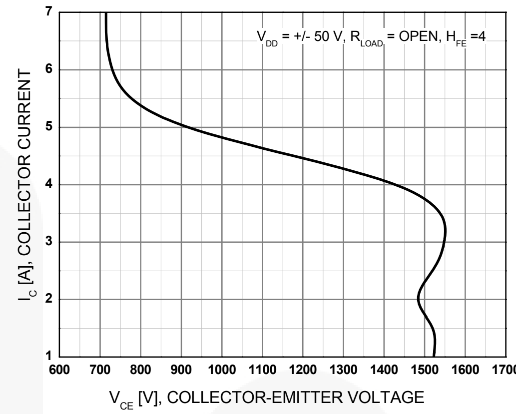


Figure 17. BJT RBSOA

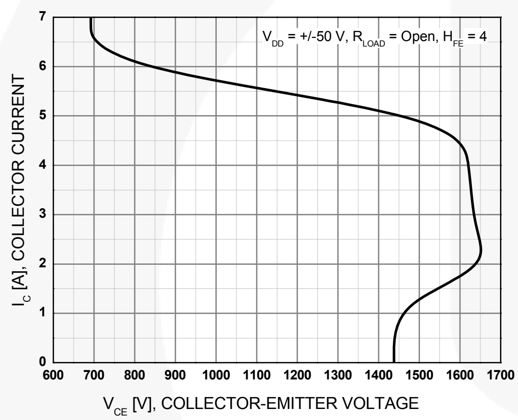


Figure 18. ESBC RBSOA

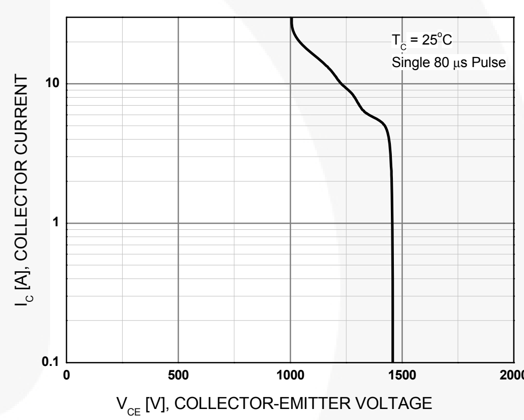


Figure 19. Crossover FBSOA

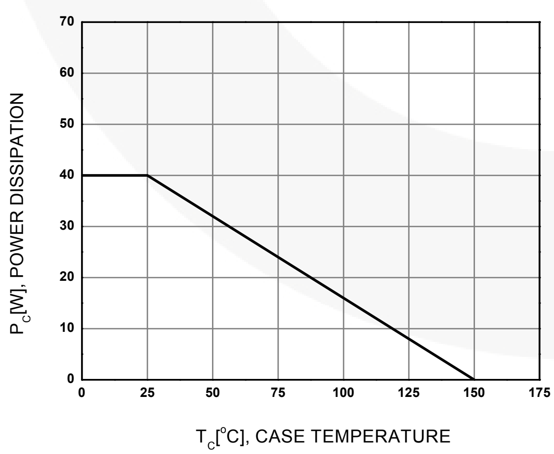


Figure 20. Power Derating

Test Circuits

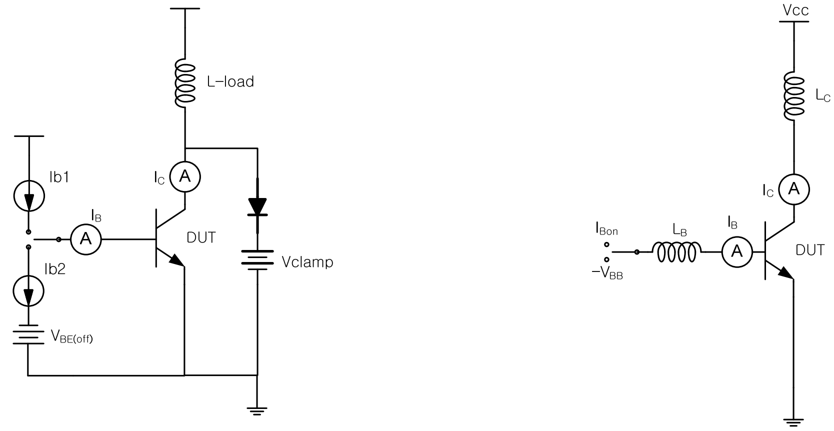


Figure 21. Test Circuit For Inductive Load and Reverse Bias Safe Operating

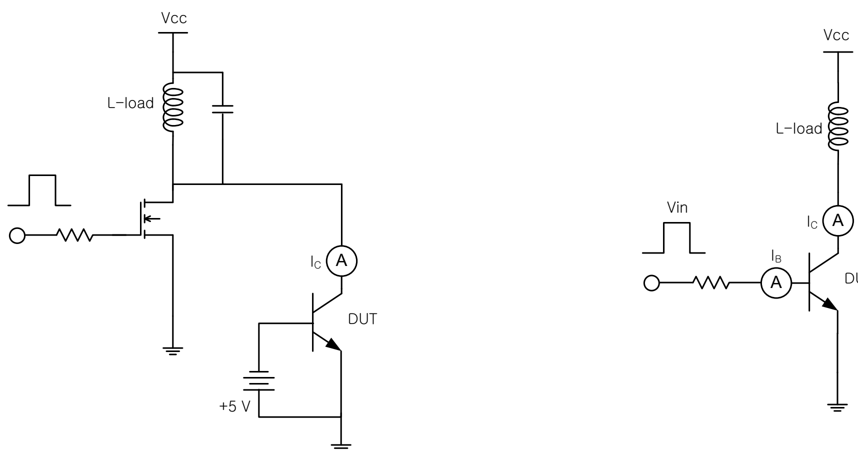


Figure 22. Energy Rating Test Circuit

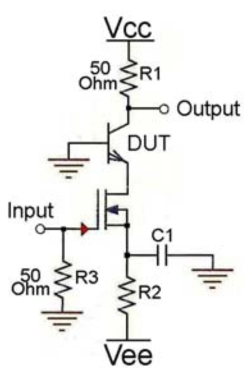


Figure 23. f_T Measurement

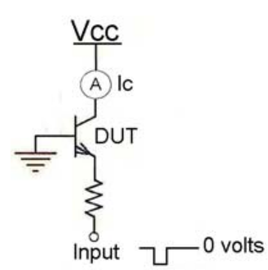


Figure 24. FBSOA

Test Circuits (Continued)

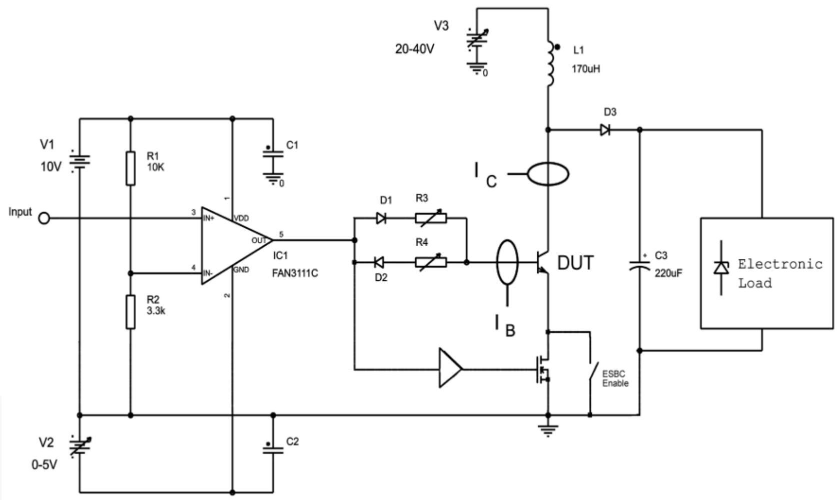


Figure 25. Simplified Saturated Switch Driver Circuit

Functional Test Waveforms

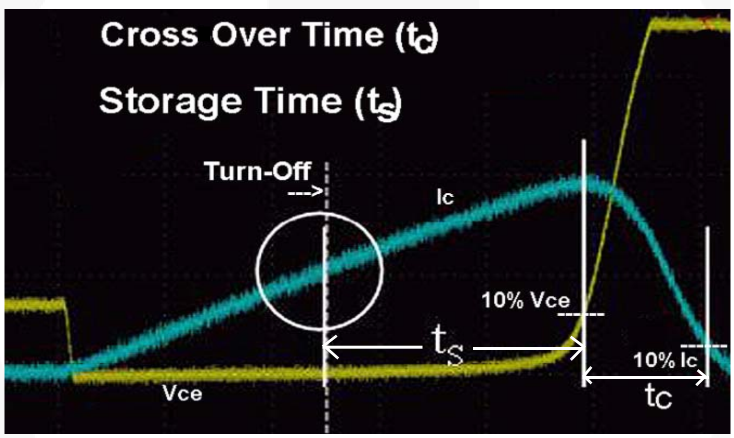


Figure 26. Crossover Time Measurement

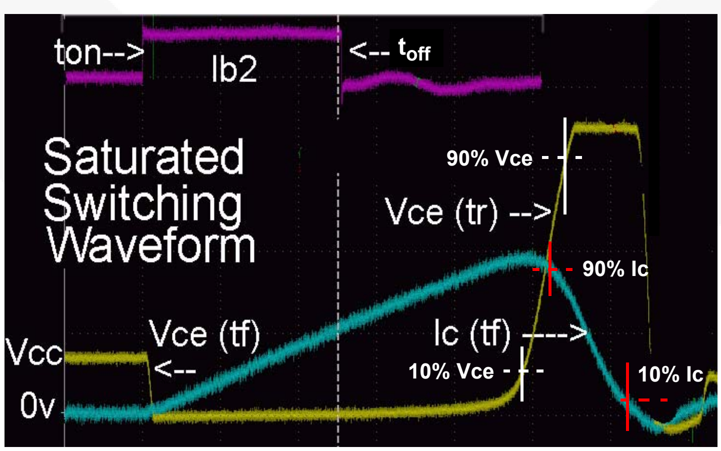


Figure 27. Saturated Switching Waveform

Functional Test Waveforms (Continued)

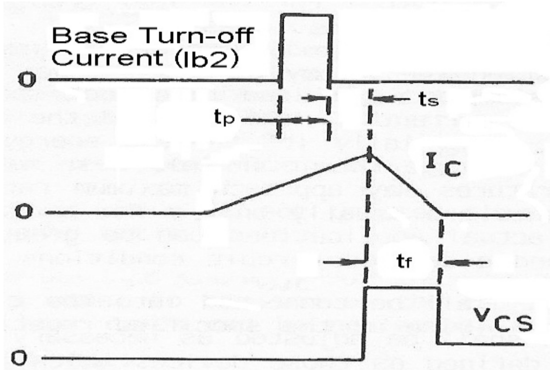


Figure 28. Storage Time - Common Emitter Base Turn Off (Ib2) to I_C Fall - time

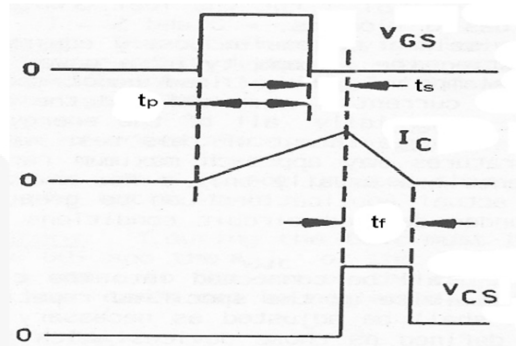
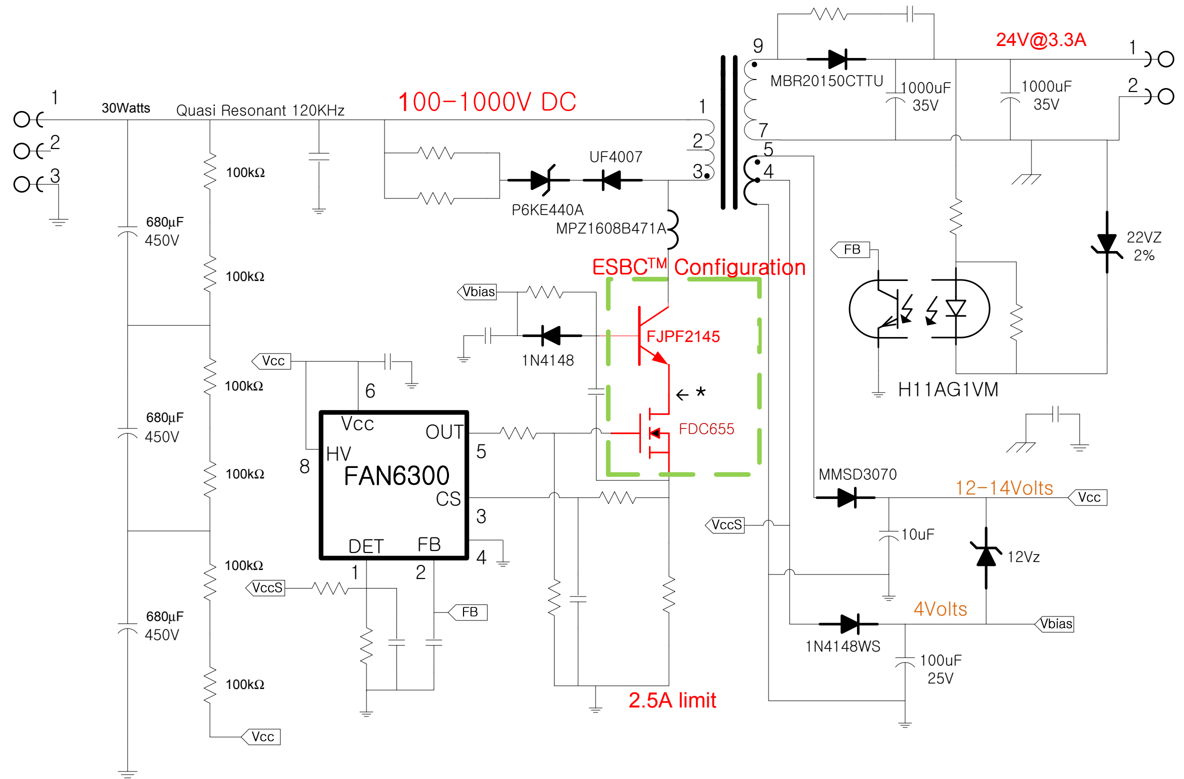


Figure 29. Storage Time - ESBC FET Gate (off) to I_C Fall - time

Very Wide Input Voltage Range Supply



* Make short as possible

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

Driving ESBC Switches

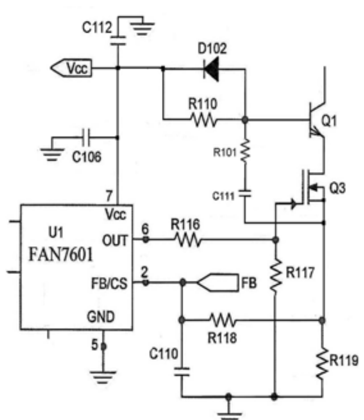


Figure 31. V_{CC} Derived

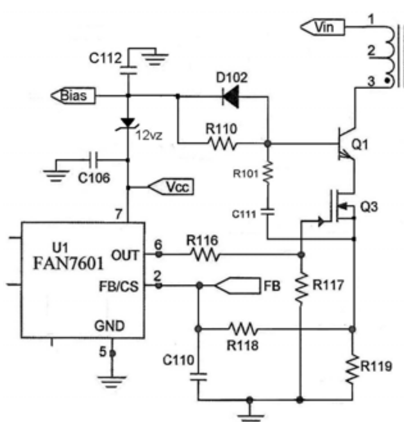


Figure 32. V_{bias} Supply Derived

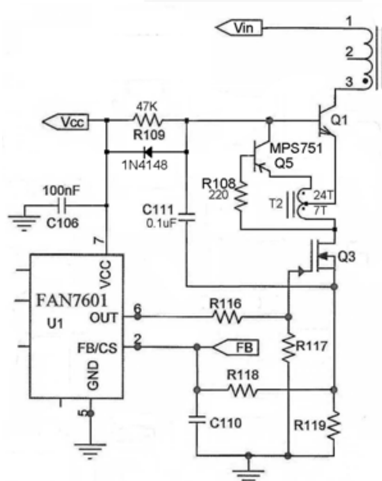


Figure 33. Proportional Drive

Physical Dimensions

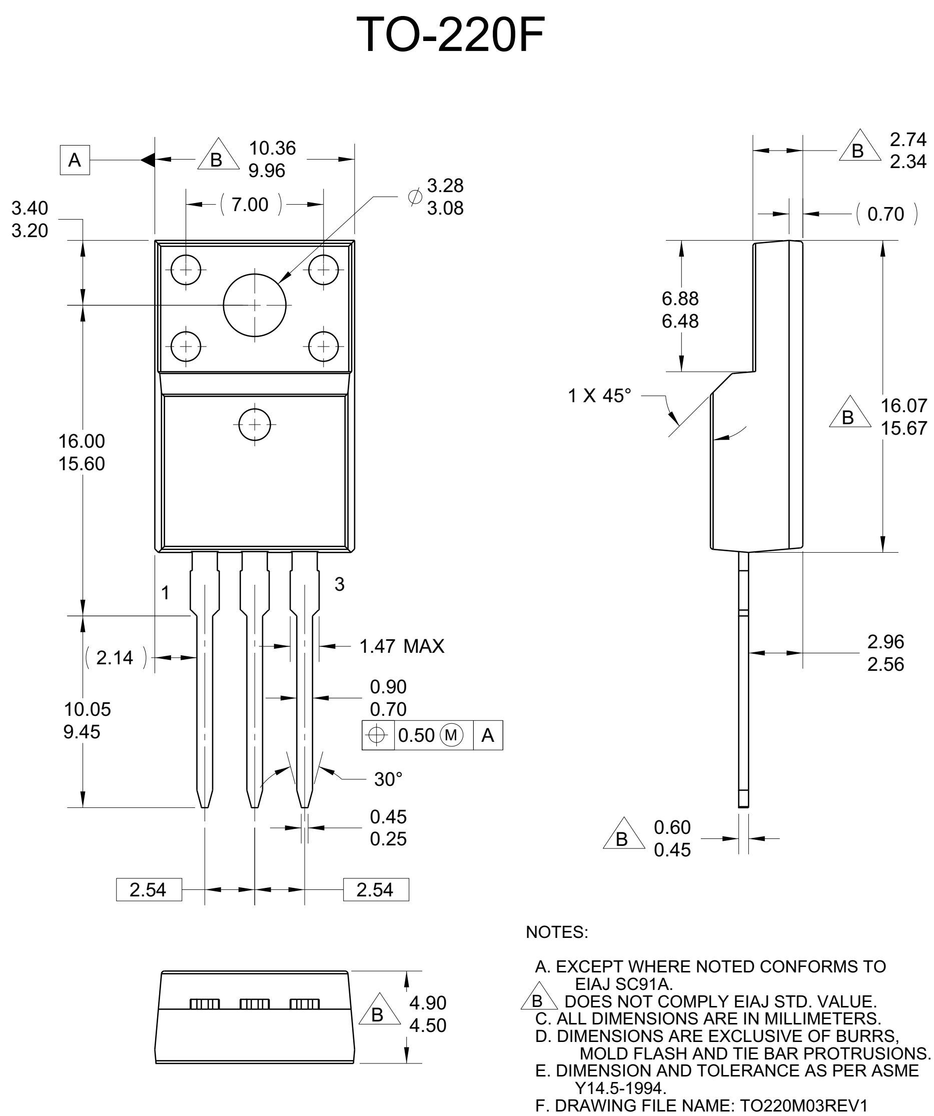


Figure 34. TO-220, MOLDED, 3-LEAD, FULL PACK EIAJ SC91, STRAIGHT LEAD

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FETBench™
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MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
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SuperSOT™-6
SuperSOT™-8
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TinyPower™
TinyPWM™
TinyWire™
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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