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# FJAFS1720

## ESBC™ Rated NPN Power Transistor

### ESBC Features (FDS8817 MOSFET)

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

- 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.

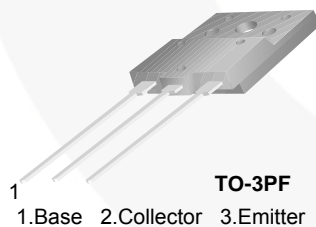


Figure 1. Pin Configuration

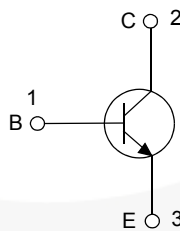


Figure 2. Internal Schematic Diagram

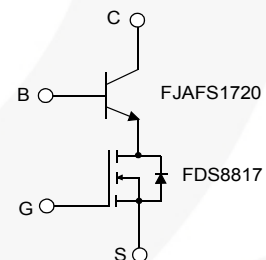


Figure 3. ESBC Configuration<sup>(2)</sup>

### 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.

**Absolute Maximum Ratings**<sup>(3)</sup>Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

Symbol	Parameter	Value	Units
$V_{CB0}$	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 ( $T_C = 25^\circ\text{C}$ )	60	W
$T_J$	Operating and Junction Temperature Range	-55 to +125	$^\circ\text{C}$
$T_{STG}$	Storage Temperature Range	-55 to +150	$^\circ\text{C}$

**Note:**3. Pulse Test is Pulse Width  $\leq 5$  ms, Duty Cycle  $\leq 10\%$ .**Thermal Characteristics**Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

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

**Electrical Characteristics**<sup>(4)</sup>Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

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

**Note:**4. Pulse Test: Pulse Width  $\leq 5$  ms, Duty Cycle  $\leq 10\%$ .

## ESBC Configured Electrical Characteristics<sup>(5)</sup>

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

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

**Note:**

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

## Typical Performance Characteristics

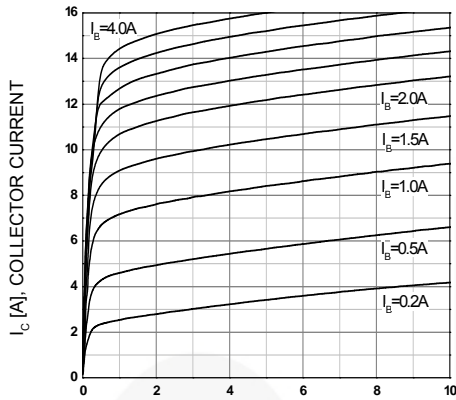


Figure 4. Static Characteristics

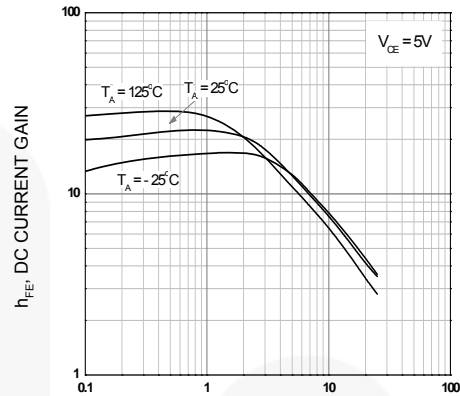


Figure 5. DC Current Gain

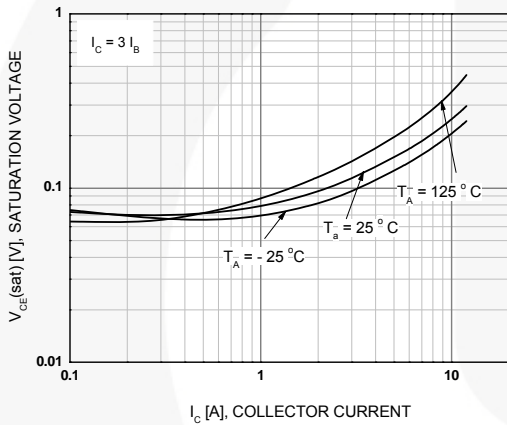


Figure 6. Collector-Emitter Saturation Voltage  
 $h_{FE}=3$

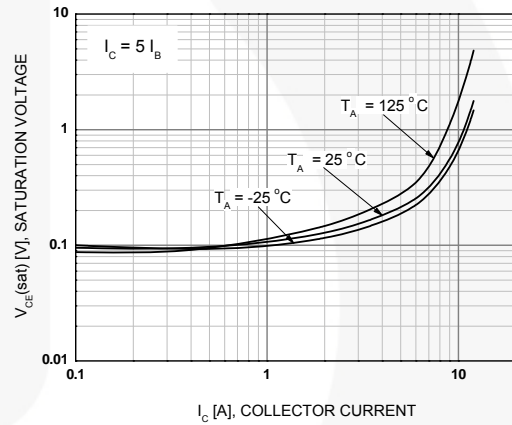


Figure 7. Collector-Emitter Saturation Voltage  
 $h_{FE}=5$

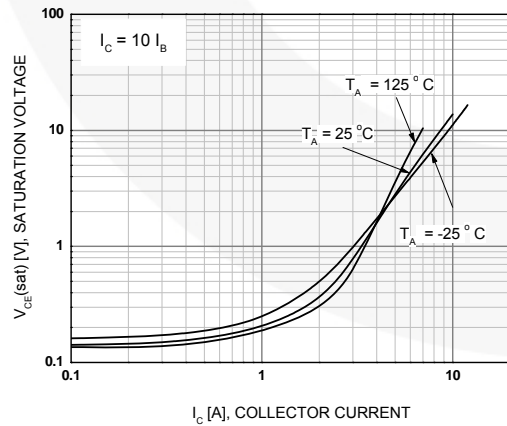


Figure 8. Collector-Emitter Saturation Voltage  
 $h_{FE}=10$

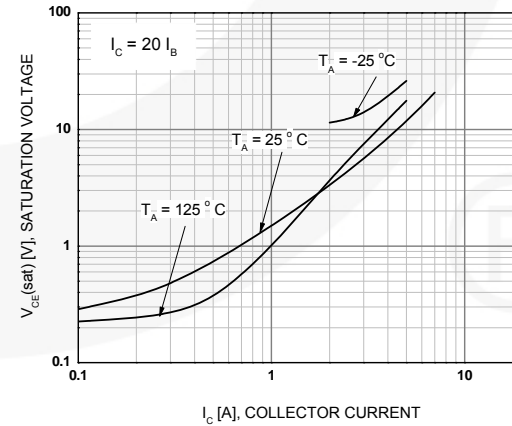
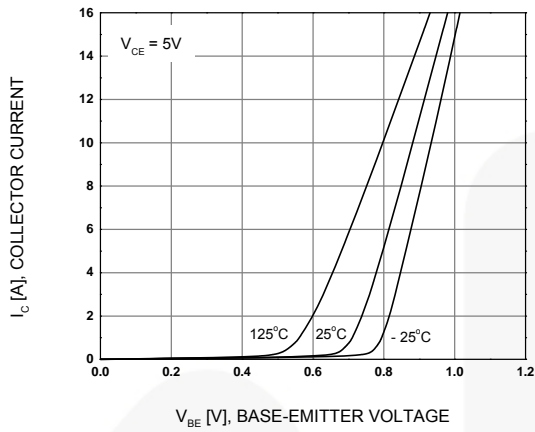
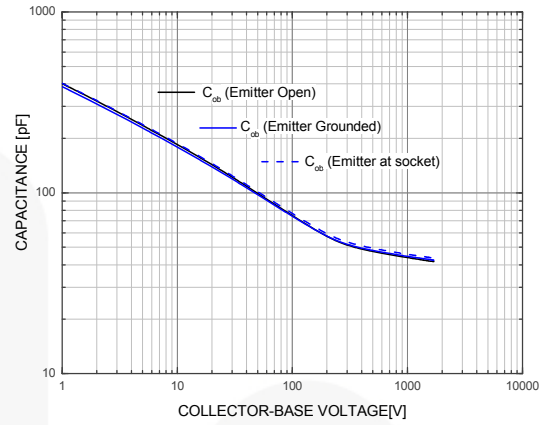


Figure 9. Collector-Emitter Saturation Voltage  
 $h_{FE}=20$

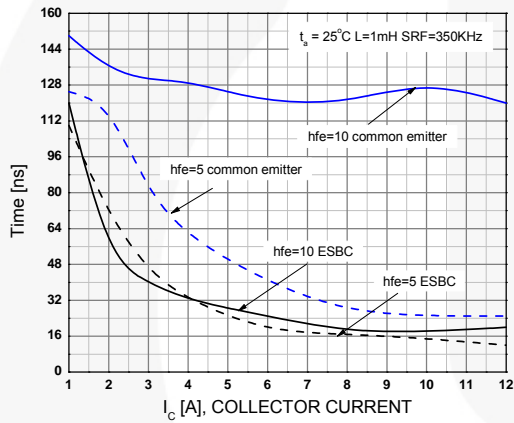
**Typical Performance Characteristics (Continued)**



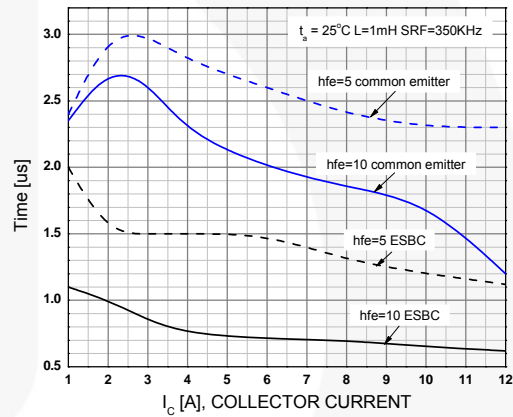
**Figure 10. Base-Emitter On Voltage**



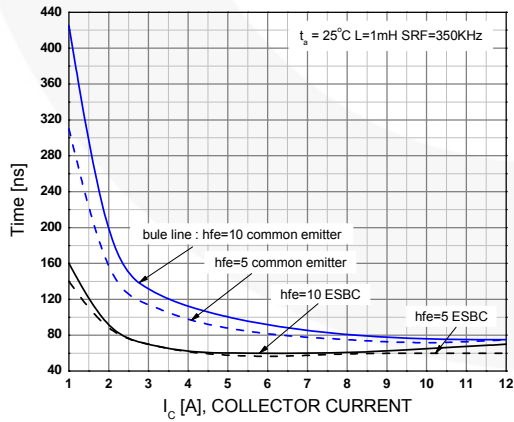
**Figure 11. Capacitance**



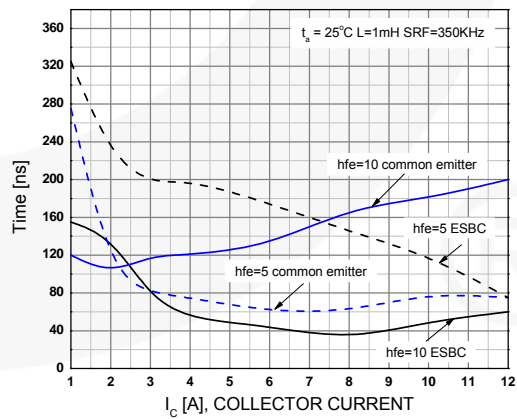
**Figure 12. Inductive Load Collector Current Fall-time ( $t_f$ )**



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

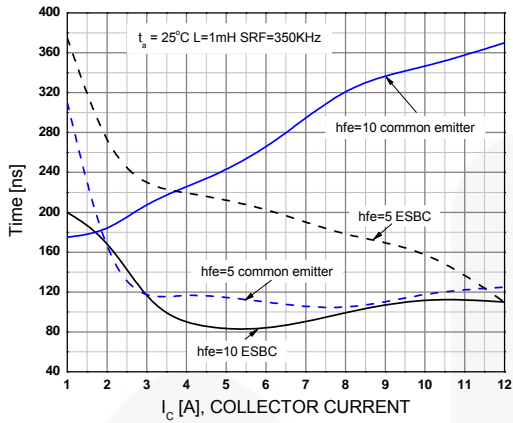


**Figure 14. Inductive Load Collector Voltage Fall-time ( $t_f$ )**

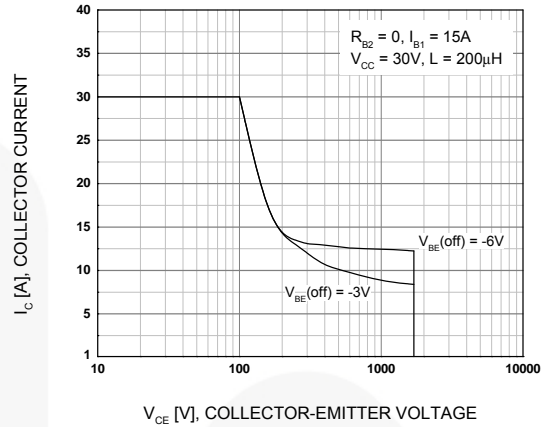


**Figure 15. Inductive Load Collector Voltage Rise-time ( $t_r$ )**

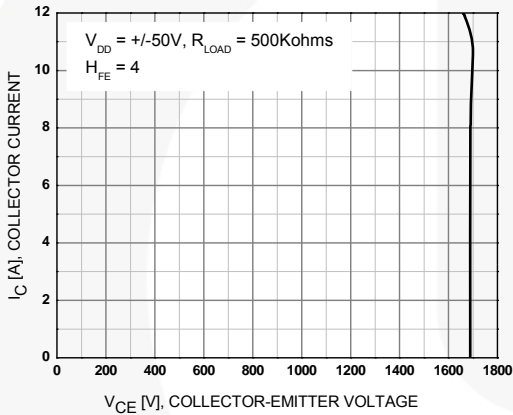
**Typical Performance Characteristics (Continued)**



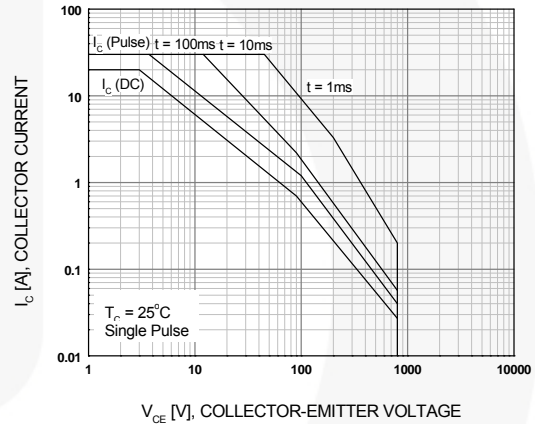
**Figure 16. Inductive Load Collector Current / Voltage Crossover ( $t_c$ )**



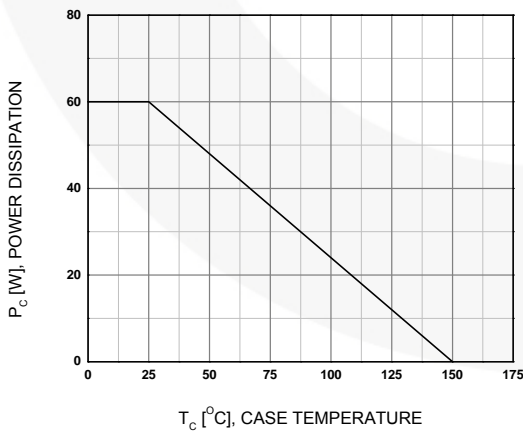
**Figure 17. Reverse Bias Safe Operating Area**



**Figure 18. ESBC RBSOA**

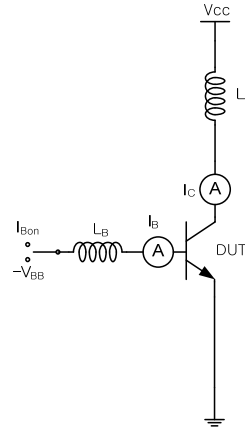
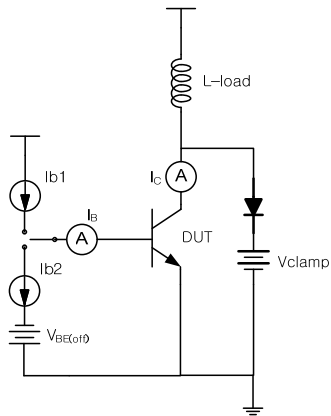


**Figure 19. Forward Bias Safe Operating Area**

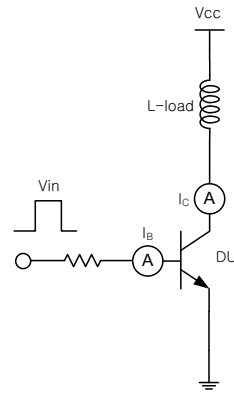
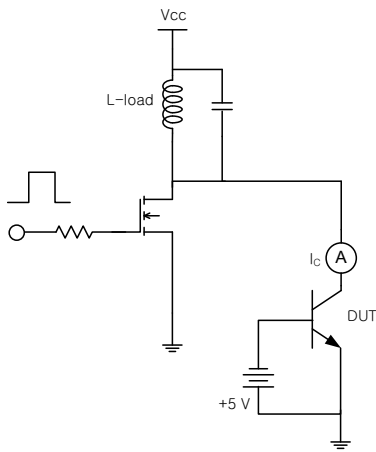


**Figure 20. Power Derating**

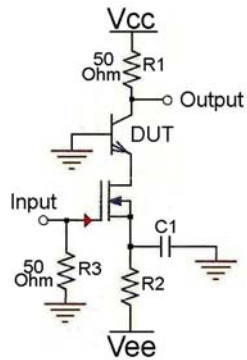
**Test Circuits**



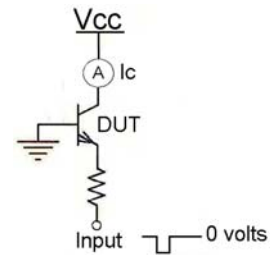
**Figure 21. Test Circuit For Inductive Load and Reverse Bias Safe Operating**



**Figure 22. Energy Rating Test Circuit**



**Figure 23.  $f_T$  Measurement**

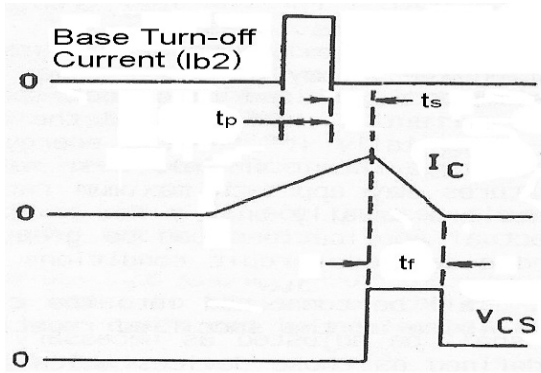


**Figure 24. FBSOA**

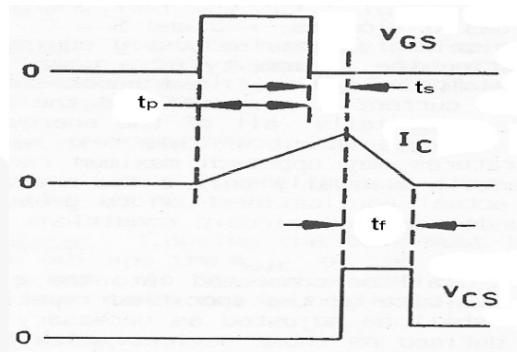




**Functional Test Waveforms (Continued)**



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

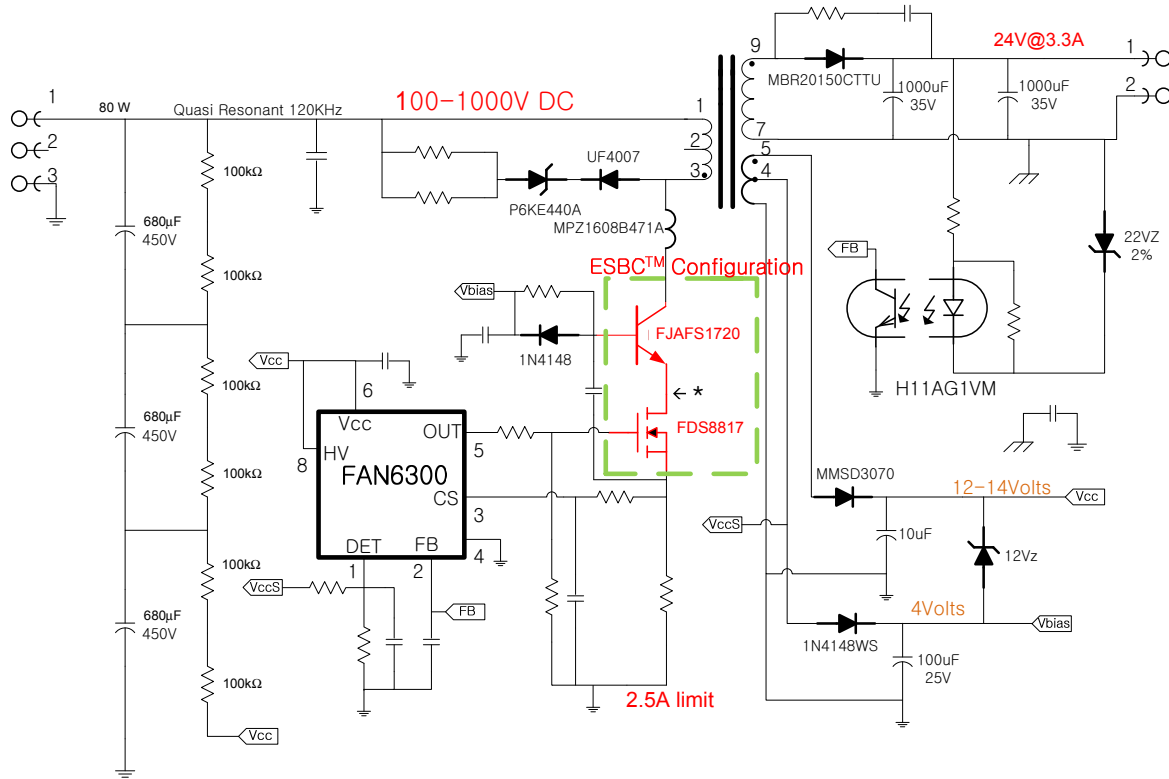


**Figure 29. Storage Time - ESBC FET  
Gate (off) to  $I_C$  Fall-Time**



## Very Wide Input Voltage Range Supply

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



\* Make short as possible

## Driving ESBC Switches

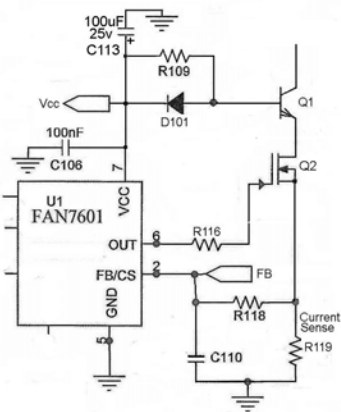


Figure30. V<sub>cc</sub> Derived

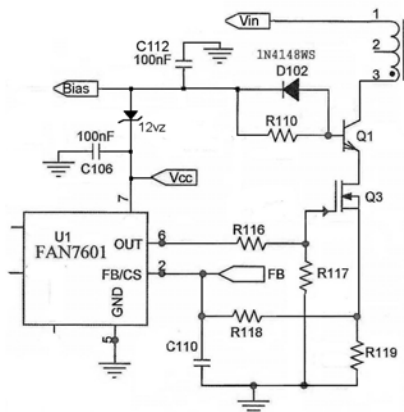


Figure31. V<sub>bias</sub> Supply Derived

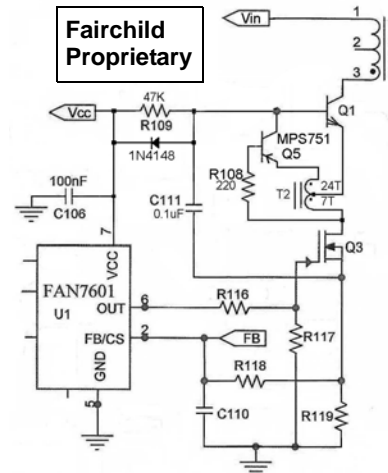
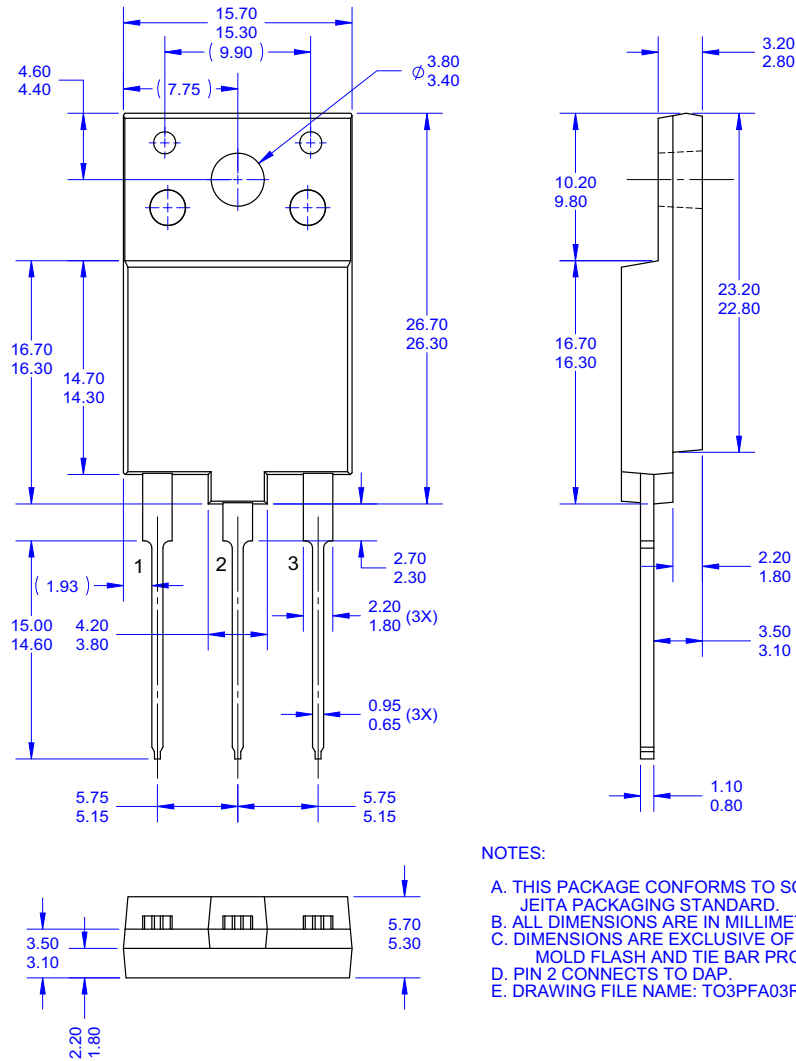


Figure32. Proportional Drive

Physical Dimensions

TO-3PF



NOTES:

- A. THIS PACKAGE CONFORMS TO SC94 JEITA PACKAGING STANDARD.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- D. PIN 2 CONNECTS TO DAP.
- E. DRAWING FILE NAME: TO3PFA03REV1

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

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<http://www.fairchildsemi.com/dwg/TO/TO3PFA03.pdf>



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| 2Cool™                   | FPS™   |                                       | Sync-Lock™       |
| AccuPower™               | F-PFS™   | PowerTrench®                          |                  |
| AX-CAP®*                 | FRFET®   | PowerXS™                              | TinyBoost™       |
| BitSiC™                  | Global Power Resource <sup>SM</sup>            | Programmable Active Droop™            | TinyBuck™        |
| Build it Now™            | GreenBridge™                                   | QFET®                                 | TinyCalc™        |
| CorePLUS™                | Green FPS™                                     | QS™                                   | TinyLogic®       |
| CorePOWER™               | Green FPS™ e-Series™                           | Quiet Series™                         | TINYOPTO™        |
| CROSSVOLT™               | Gmax™  | RapidConfigure™                       | TinyPower™       |
| CTL™                     | GTO™   |                                       | TinyPWM™         |
| Current Transfer Logic™  | IntelliMAX™                                    | Saving our world, 1mW/W/kW at a time™ | TinyWire™        |
| DEUXPEED®                | ISOPLANAR™                                     | SignalWise™                           | TranSiC™         |
| Dual Cool™               | Making Small Speakers Sound Louder and Better™ | SmartMax™                             | TriFault Detect™ |
| EcoSPARK®                | MegaBuck™                                      | SMART START™                          | TRUECURRENT®*    |
| EfficientMax™            | MICROCOUPLER™                                  | Solutions for Your Success™           | μSerDes™         |
| ESBC™                    | MicroFET™                                      | SPM®                                  |                  |
|                          | MicroPak™                                      | STEALTH™                              | UHC®             |
| Fairchild®               | MicroPak2™                                     | SuperFET®                             | Ultra FRFET™     |
| Fairchild Semiconductor® | MillerDrive™                                   | SuperSOT™-3                           | UniFET™          |
| FACT Quiet Series™       | MotionMax™                                     | SuperSOT™-6                           | VCX™             |
| FACT®                    | mWSaver™                                       | SuperSOT™-8                           | VisualMax™       |
| FAST®                    | OptoHiT™                                       | SupreMOS®                             | VoltagePlus™     |
| FastvCore™               | OPTOLOGIC®                                     | SyncFET™                              | XS™              |
| FETBench™                | OPTOPLANAR®                                    |                                       |                  |

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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.

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**Definition of Terms**

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