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# FGAF40N60UFD

## Ultrafast IGBT

### General Description

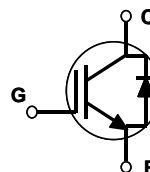
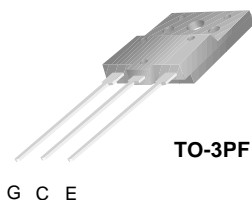
Fairchild's UFD series of Insulated Gate Bipolar Transistors (IGBTs) provides low conduction and switching losses. The UFD series is designed for applications such as motor control and general inverters where high speed switching is a required feature.

### Features

- High speed switching
- Low saturation voltage :  $V_{CE(sat)} = 2.3 \text{ V @ } I_C = 20\text{A}$
- High input impedance
- CO-PAK, IGBT with FRD :  $t_{rr} = 50\text{ns (typ.)}$

### Applications

AC & DC motor controls, general purpose inverters, robotics, and servo controls.



### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

Symbol	Description	FGAF40N60UFD	Units
$V_{CES}$	Collector-Emitter Voltage	600	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	40	A
	Collector Current @ $T_C = 100^\circ\text{C}$	20	A
$I_{CM(1)}$	Pulsed Collector Current	160	A
$I_F$	Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$	15	A
$I_{FM}$	Diode Maximum Forward Current	160	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	100	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	40	W
$T_J$	Operating Junction Temperature	-55 to +150	$^\circ\text{C}$
$T_{stg}$	Storage Temperature Range	-55 to +150	$^\circ\text{C}$
$T_L$	Maximum Lead Temp. for Soldering Purposes, 1/8" from Case for 5 Seconds	300	$^\circ\text{C}$

#### Notes :

(1) Repetitive rating : Pulse width limited by max. junction temperature

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}(\text{IGBT})$	Thermal Resistance, Junction-to-Case	--	1.2	$^\circ\text{C/W}$
$R_{\theta JC}(\text{DIODE})$	Thermal Resistance, Junction-to-Case	--	2.6	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	--	40	$^\circ\text{C/W}$

## Electrical Characteristics of the IGBT T<sub>C</sub> = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
<b>Off Characteristics</b>						
BV <sub>CES</sub>	Collector-Emitter Breakdown Voltage	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250uA	600	--	--	V
ΔBV <sub>CES</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA	--	0.6	--	V/°C
I <sub>CES</sub>	Collector Cut-Off Current	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0V	--	--	250	uA
I <sub>GES</sub>	G-E Leakage Current	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0V	--	--	± 100	nA

### On Characteristics

V <sub>GE(th)</sub>	G-E Threshold Voltage	I <sub>C</sub> = 20mA, V <sub>CE</sub> = V <sub>GE</sub>	3.5	5.1	6.5	V
V <sub>CE(sat)</sub>	Collector to Emitter Saturation Voltage	I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V	--	2.3	3.0	V
		I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V	--	3.1	--	V

### Dynamic Characteristics

C <sub>ies</sub>	Input Capacitance	V <sub>CE</sub> = 30V, V <sub>GE</sub> = 0V, f = 1MHz	--	1075	--	pF
C <sub>oes</sub>	Output Capacitance		--	170	--	pF
C <sub>res</sub>	Reverse Transfer Capacitance		--	50	--	pF

### Switching Characteristics

t <sub>d(on)</sub>	Turn-On Delay Time	V <sub>CC</sub> = 300 V, I <sub>C</sub> = 20A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 25°C	--	15	--	ns
t <sub>r</sub>	Rise Time		--	30	--	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		--	65	130	ns
t <sub>f</sub>	Fall Time		--	35	100	ns
E <sub>on</sub>	Turn-On Switching Loss		--	470	--	uJ
E <sub>off</sub>	Turn-Off Switching Loss	V <sub>CC</sub> = 300 V, I <sub>C</sub> = 20A, R <sub>G</sub> = 10Ω, V <sub>GE</sub> = 15V, Inductive Load, T <sub>C</sub> = 125°C	--	130	--	uJ
E <sub>ts</sub>	Total Switching Loss		--	600	1000	uJ
t <sub>d(on)</sub>	Turn-On Delay Time		--	30	--	ns
t <sub>r</sub>	Rise Time		--	37	--	ns
t <sub>d(off)</sub>	Turn-Off Delay Time		--	110	200	ns
t <sub>f</sub>	Fall Time		--	80	250	ns
E <sub>on</sub>	Turn-On Switching Loss	V <sub>CE</sub> = 300 V, I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V	--	500	--	uJ
E <sub>off</sub>	Turn-Off Switching Loss		--	310	--	uJ
E <sub>ts</sub>	Total Switching Loss		--	810	1200	uJ
Q <sub>g</sub>	Total Gate Charge		--	77	150	nC
Q <sub>ge</sub>	Gate-Emitter Charge		--	20	30	nC
Q <sub>gc</sub>	Gate-Collector Charge	Measured 5mm from PKG	--	25	40	nC
L <sub>e</sub>	Internal Emitter Inductance		--	14	--	nH

## Electrical Characteristics of DIODE T<sub>C</sub> = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Units
V <sub>FM</sub>	Diode Forward Voltage	I <sub>F</sub> = 15A	T <sub>C</sub> = 25°C	--	1.4	1.7	V
			T <sub>C</sub> = 100°C	--	1.3	--	
t <sub>rr</sub>	Diode Reverse Recovery Time	I <sub>F</sub> = 15A, di/dt = 200A/us	T <sub>C</sub> = 25°C	--	50	95	ns
			T <sub>C</sub> = 100°C	--	74	--	
I <sub>rr</sub>	Diode Peak Reverse Recovery Current		T <sub>C</sub> = 25°C	--	4.5	6.0	A
			T <sub>C</sub> = 100°C	--	6.5	--	
Q <sub>rr</sub>	Diode Reverse Recovery Charge		T <sub>C</sub> = 25°C	--	80	180	nC
			T <sub>C</sub> = 100°C	--	220	--	

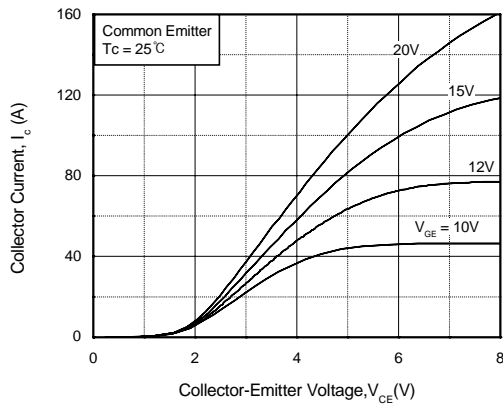


Fig 1. Typical Output Characteristics

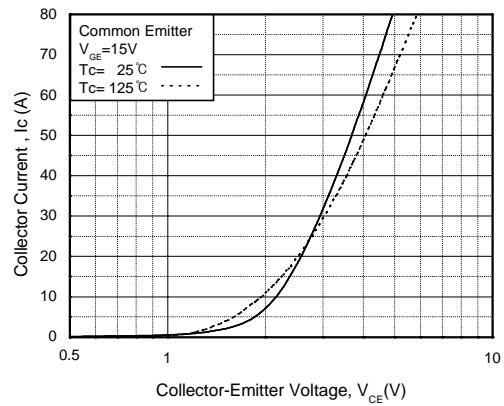


Fig 2. Typical Saturation Voltage Characteristics

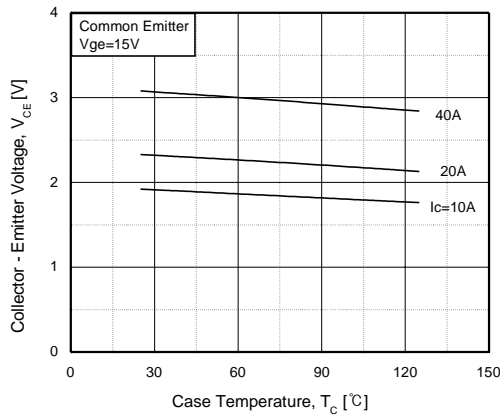


Fig 3. Saturation Voltage vs. Case Temperature at Variant Current Level

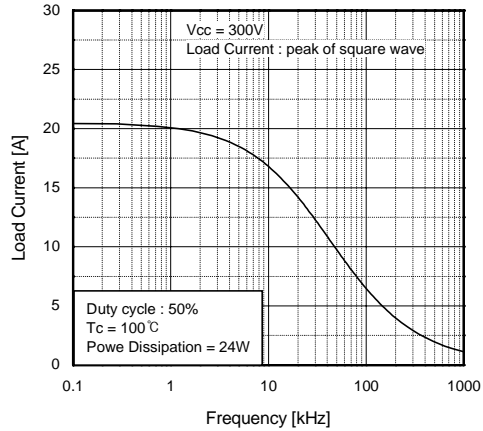


Fig 4. Load Current vs. Frequency

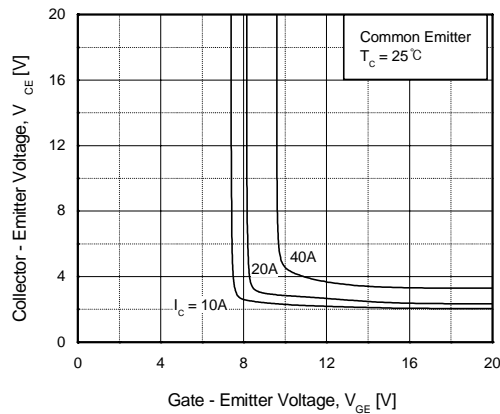


Fig 5. Saturation Voltage vs.  $V_{GE}$

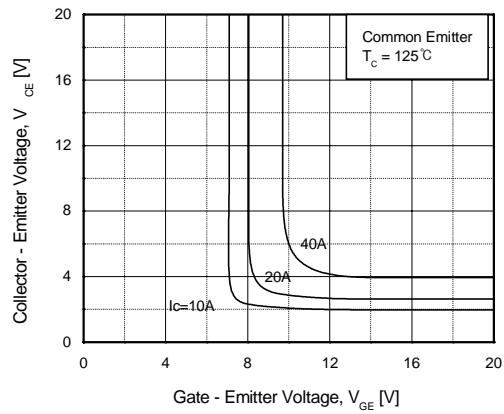


Fig 6. Saturation Voltage vs.  $V_{GE}$

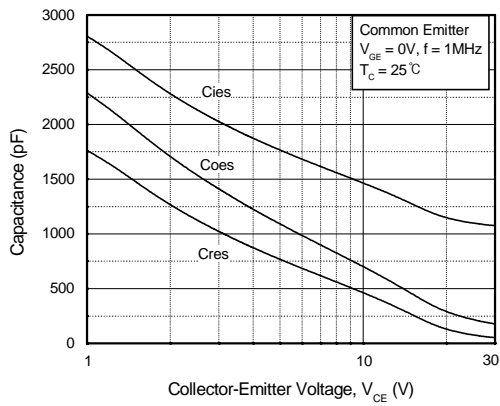


Fig 7. Capacitance Characteristics

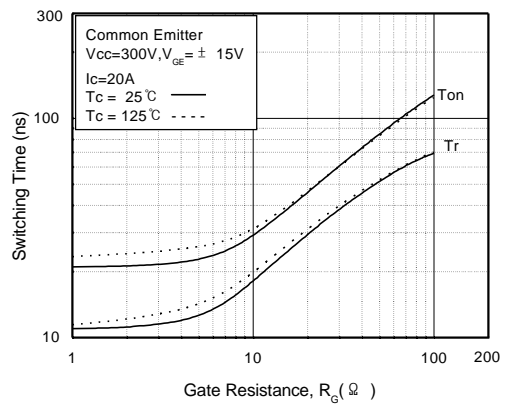


Fig 8. Turn-On Characteristics vs. Gate Resistance

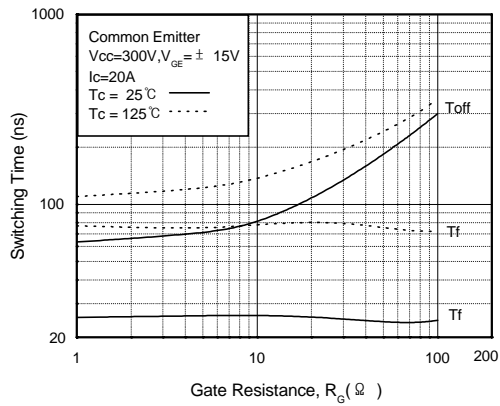


Fig 9. Turn-Off Characteristics vs. Gate Resistance

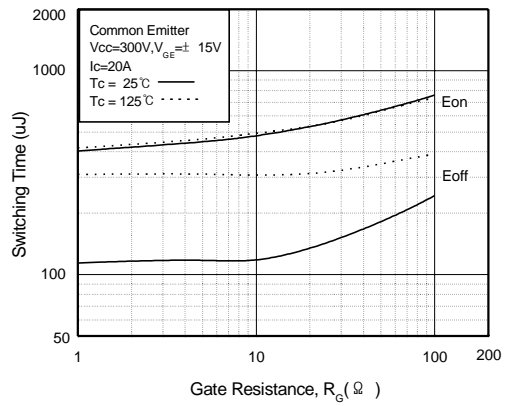


Fig 10. Switching Loss vs. Gate Resistance

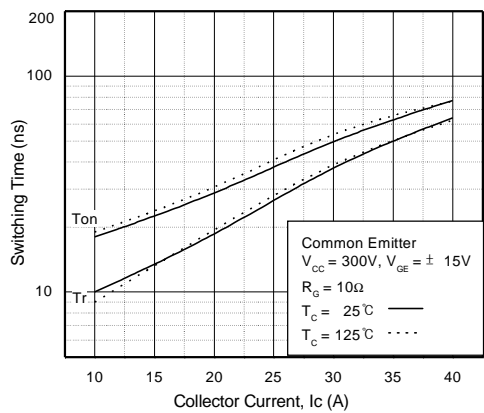


Fig 11. Turn-On Characteristics vs. Collector Current

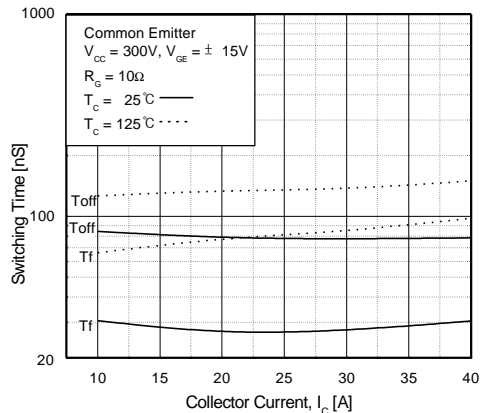


Fig 12. Turn-Off Characteristics vs. Collector Current

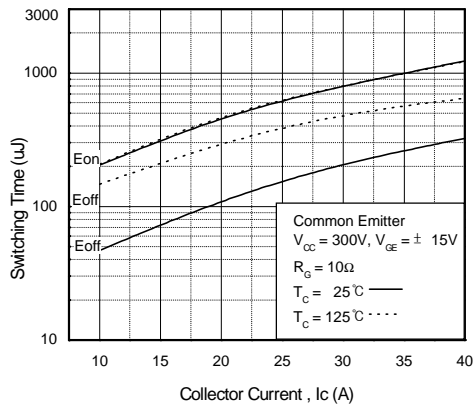


Fig 13. Switching Loss vs. Collector Current

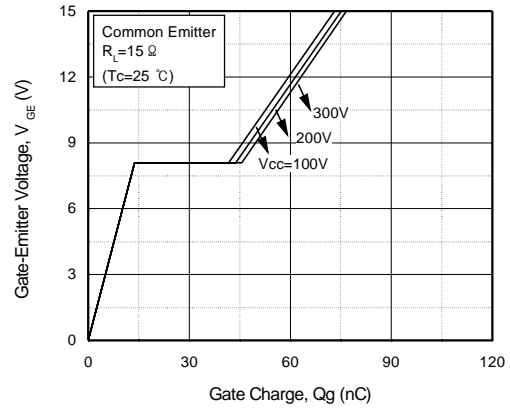


Fig 14. Gate Charge Characteristics

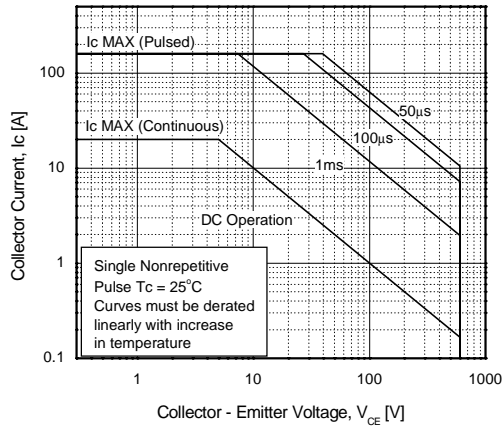


Fig 15. SOA Characteristics

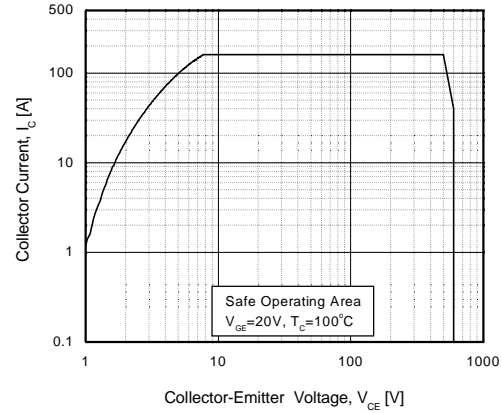


Fig 16. Turn-Off SOA Characteristics

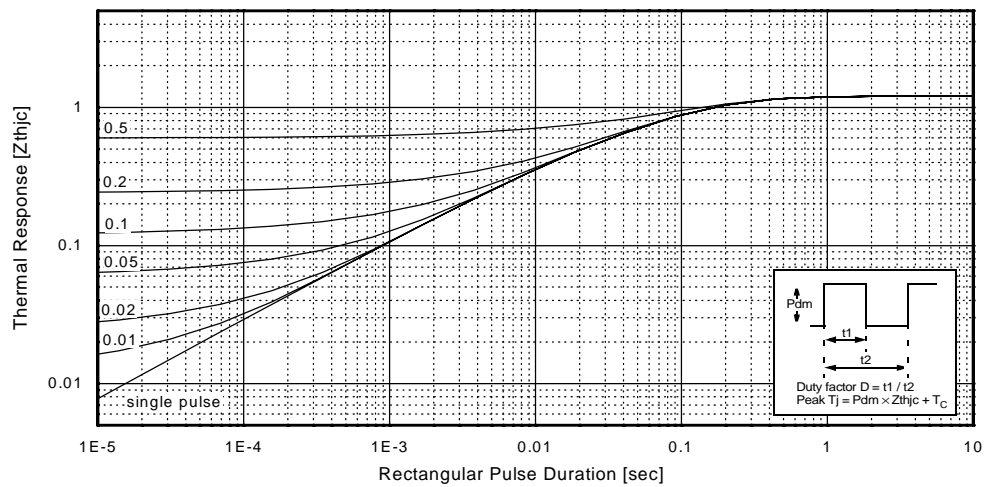


Fig 17. Transient Thermal Impedance of IGBT

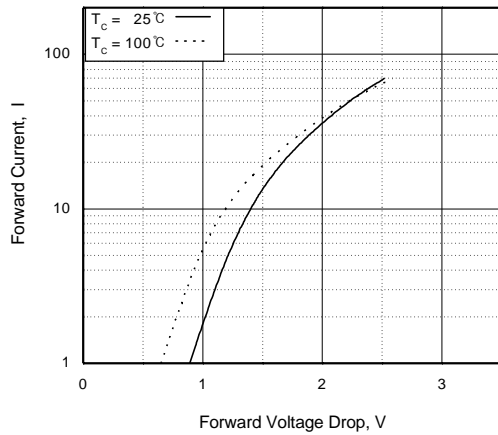


Fig 18. Forward Characteristics

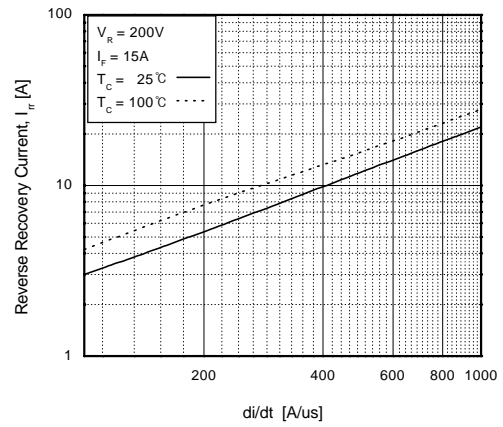


Fig 19. Reverse Recovery Current

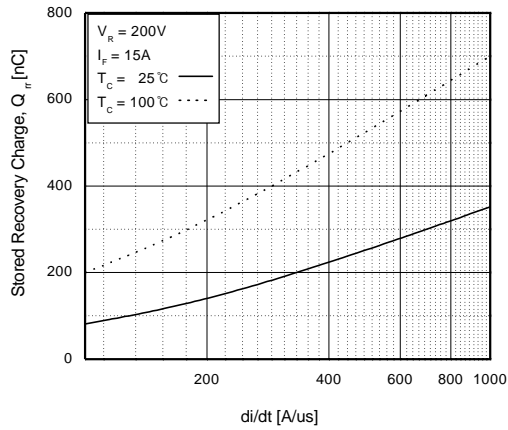


Fig 20. Stored Charge

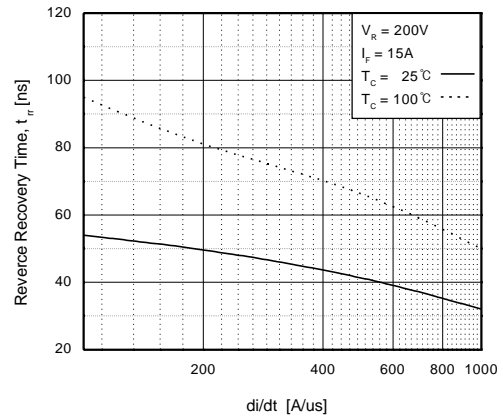


Fig 21. Reverse Recovery Time

Technical drawing of a mechanical part, showing three views: front, side, and top. The drawing includes dimensions and tolerances.

**Front View Dimensions:**

- Overall width:  $15.50 \pm 0.20$
- Overall height:  $26.50 \pm 0.20$
- Top section height:  $4.50 \pm 0.20$
- Central slot width:  $2.00 \pm 0.20$
- Pin diameter:  $\varnothing 3.60 \pm 0.20$
- Pin length (from top surface):  $14.50 \pm 0.20$
- Pin length (from bottom surface):  $14.80 \pm 0.20$
- Pin diameter (bottom):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (top):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (middle):  $0.75^{+0.20}_{-0.10}$
- Pin diameter (bottom):  $0.85 \pm 0.03$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$

**Side View Dimensions:**

- Overall height:  $22.00 \pm 0.20$
- Top section height:  $5.50 \pm 0.20$
- Central slot width:  $2.00 \pm 0.20$
- Pin diameter:  $\varnothing 3.60 \pm 0.20$
- Pin length (from top surface):  $10.00 \pm 0.20$
- Pin length (from bottom surface):  $16.50 \pm 0.20$
- Pin diameter (bottom):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (top):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (middle):  $0.75^{+0.20}_{-0.10}$
- Pin diameter (bottom):  $0.85 \pm 0.03$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$

**Top View Dimensions:**

- Overall width:  $5.50 \pm 0.20$
- Overall height:  $3.30 \pm 0.20$
- Top section height:  $2.00 \pm 0.20$
- Central slot width:  $2.00 \pm 0.20$
- Pin diameter:  $\varnothing 3.60 \pm 0.20$
- Pin length (from top surface):  $10.00 \pm 0.20$
- Pin length (from bottom surface):  $16.50 \pm 0.20$
- Pin diameter (bottom):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (top):  $5.45 \text{ TYP}$  [ $5.45 \pm 0.30$ ]
- Pin diameter (middle):  $0.75^{+0.20}_{-0.10}$
- Pin diameter (bottom):  $0.85 \pm 0.03$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$
- Pin diameter (top):  $2.00 \pm 0.20$
- Pin diameter (middle):  $2.00 \pm 0.20$
- Pin diameter (bottom):  $2.00 \pm 0.20$

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