CFGS AUTOMATIZACIÓ I ROBOTICA INDUSTRIAL

MÒDUL 4: SISTEMES ELECTROTÈCNICS DE POTÈNCIA

UF 2: Màquines elèctriques

Activitat 4. Exercici control de velocitat d'un motor de cc

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Curs: 2021-2022

Data: Dimarts 19 d' Abril del 2022

Activitat 4. Exercici control de velocitat d'un motor de cc

Objectiu

Dissenyar un rectificador controlat per a un motor de cc.

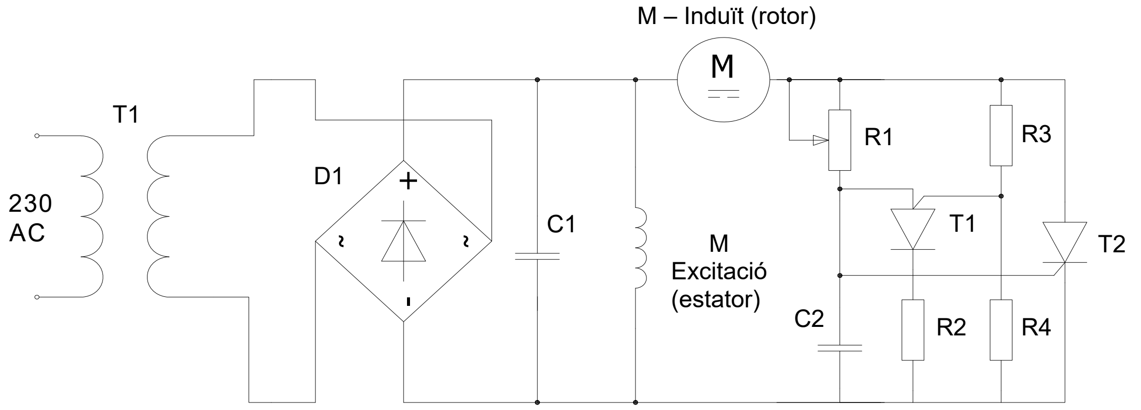
Activitats

Disposem d'un motor de cc amb les següents característiques:

Potència: 200 W
Velocitat: 1.500 rpm

Tensió excitació:	195 V	I excitació:	0,3 A	R excitació:	650Ω
Tensió alimentació:	160 V	I alimentació:	1,7 A	R induït:	94,12Ω

Per a facilitar el disseny del rectificador treballarem amb un transformador de 230/125V es faran els càlculs considerant el condensador C1, tanmateix el muntatge es farà sense.



Cal dissenyar el rectificador controlat necessari per alimentar el motor, determinant els següents paràmetres:

- Transformador necessari (amb alimentació monofàsica)
- Pont de díodes necessaris per a suportar la intensitat amb un marge de seguretat del 200%
- Dissipador necessari per al pont de díodes i per al tiristor per a la potència a dissipar (simular el circuit amb el Multisim per a veure quina serà la potència – tensió en borns dels components per intensitat que hi circula que dissiparà el pont de díodes i el tiristor i fer els càlculs amb els paràmetres determinats i considerant una temperatura ambient de 40 ºC)
- Condensador necessari amb un arrissat màxim de 5V - únicament a efectes de càlcul
- Tiristor necessari amb un marge de seguretat del 200%.
- Per al circuit de comandament agafa'l de l'exemple que us vaig passar modificant el valor de resistències per tal que reguli correctament de 0 a 150V

Presenta un informe amb el següent contingut:

- Portada
- Enunciat (aquest pdf)
- Esquema del muntatge amb indicació dels components (amb el Multisim)
- Càlculs efectuats (taules, fórmules, etc)
- Datasheets dels components (díodes, tiristor, dissipadors de temperatura, etc)

Índex

1. Càlculs efectuats

Dades:
Potencia: 40W
Tensió excitació: 195V
Tensió alimentació 160V
I excitació: 0,3A
I alimentació: 1,7A
R excitació: 650Ω
R induït: 94,12 Ω

- Transformador necessari (Monofàsic)
Transformador de 230 AC Monofàsic a 125 AC Monofàsic.

$$Vmed = \frac{Vmax}{\sqrt{2}} = \frac{195V}{\sqrt{2}} = 137{,}89V$$
$$Vf = \frac{Vmed}{1{,}11} = \frac{137{,}89V}{1{,}11} = 124{,}22V$$

- Pont de díodes necessari:
Pont de díodes monofàsic ona complerta 4A 200V mínim.

$$Itotal = I1 + I2 = 0{,}3A + 1{,}7A = 2A$$
$$Marge\ de\ seguretat\ 200\% = \frac{2A * 200}{100} = 4\ A$$
$$Vmax = Vmed * 1{,}57 = 125V * 1{,}57 = 196{,}25V$$

Díode escollit que estigui en la base de dades del Multisim i superior a 4A de 200V es el pont de díodes d'ona complerta monofàsic MDA2502 un pont de díodes de la marca Motorola de 200V i 25A.

- Tiristor escollit:
Tiristor 2N1774 de 200V i 4,7A deixant el 200% de seguretat en la intensitat.

$$Itotal = I1 + I2 = 0{,}3A + 1{,}7A = 2A$$
$$Marge\ de\ seguretat\ 200\% = \frac{2A * 200}{100} = 4\ A$$
$$Vmax = Vmed * 1{,}57 = 125V * 1{,}57 = 196{,}25V$$

- Dissipador necessari:

Dissipador escollit hs14-1852840 de 2ºC/W.

Càlcul dissipador pont díodes:
Tj = 175 ºC
Tamb = 40 ºC
P = 40W
Rtj j-mb= 2 ºC/W

$$Rtj\ h-a=\frac{Tj-Tamb}{P}-(Rtj\ j-mb)=\frac{175ºC-40ºC}{40W}-2ºC/W=3{,}375-\ 2=1{,}375\ ºC/W$$

Càlcul dissipador tiristor:
Tj = 125 ºC
Tamb = 40 ºC
P = 40W
Rtj j-mb= 1,5 ºC/W

$$Rtj\ h-a=\frac{Tj-Tamb}{P}-(Rtj\ j-mb)=\frac{125ºC-40ºC}{40W}-1{,}5ºC/W=2{,}125-\ 1{,}5=0{,}625\ ºC/W$$

Dissipador necessari:

$$Rtj\ h-a\ (\,Total)=1{,}375ºC/W+0{,}625ºC/W=2ºC/W$$

- Condensador:

Condensador escollit 101C402T200EE2B de 200V i 4000uF
Vmed: 125V
R excitació: 650Ω
R induït: 94,12 Ω
Vriz: 5V

$$Rt=\frac{1}{\frac{1}{R1}+\frac{1}{R2}}=\frac{1}{\frac{1}{94{,}12}+\frac{1}{600}}=\frac{1}{0{,}0106+\ 0{,}0016}=\frac{1}{0{,}0122}=\ 81{,}96\ \Omega$$

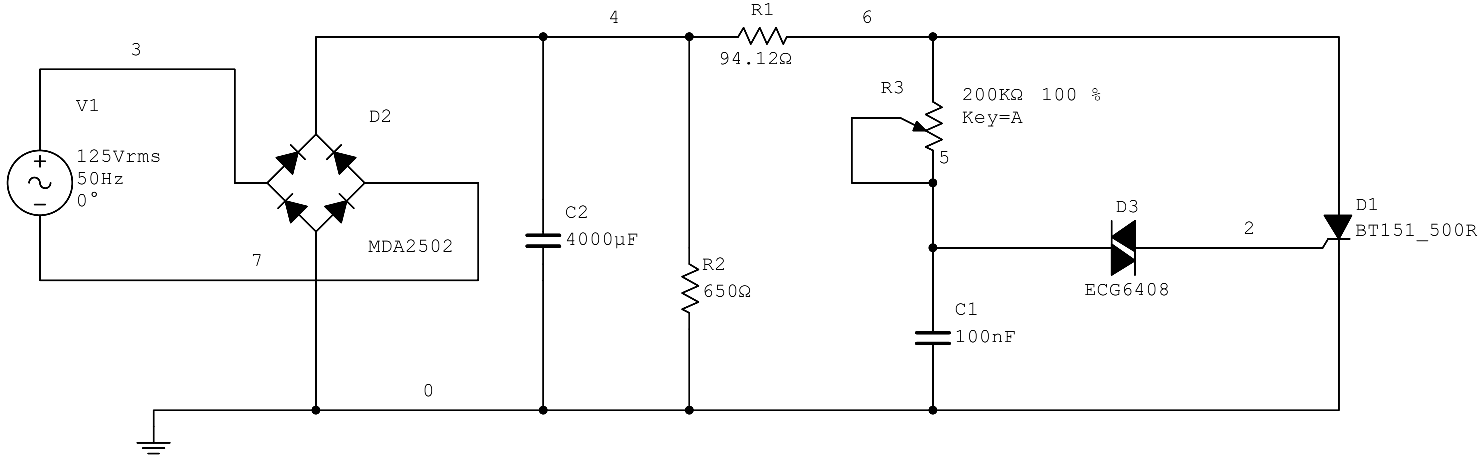
$$Vmax=Vmed\cdot\ \sqrt{2}=125\cdot\ \sqrt{2}=176{,}8V$$

$$Vmed=Vmax-\frac{Vriz}{2}=176{,}8V-\frac{5V}{2}=174{,}3V$$

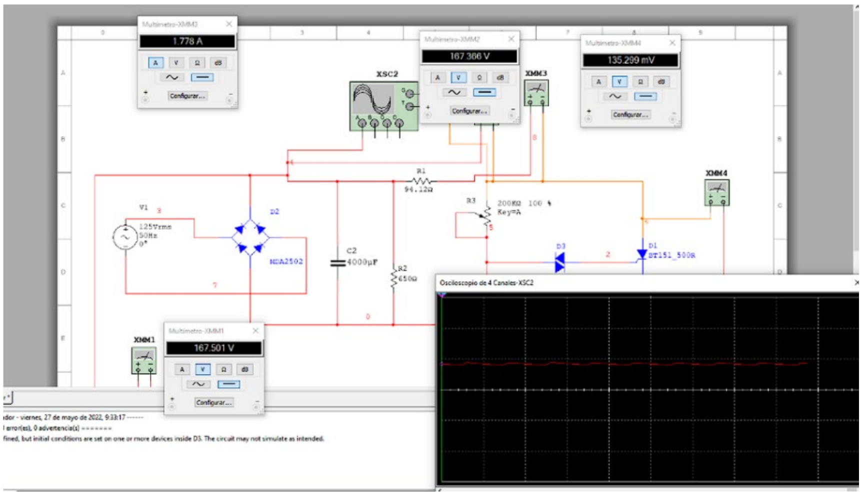
$$Imed=\frac{Vmed}{Rt}=\frac{174{,}3V}{81{,}96}=\ 2{,}12A$$

$$C=\frac{Imed}{fr\cdot Vriz}=\frac{2{,}12A}{(50Hz\cdot 2)\cdot 5V}=\frac{2{,}12A}{100Hz\cdot 5V}=\frac{2{,}12A}{500}=\ 0{,}004F=4.000uF$$

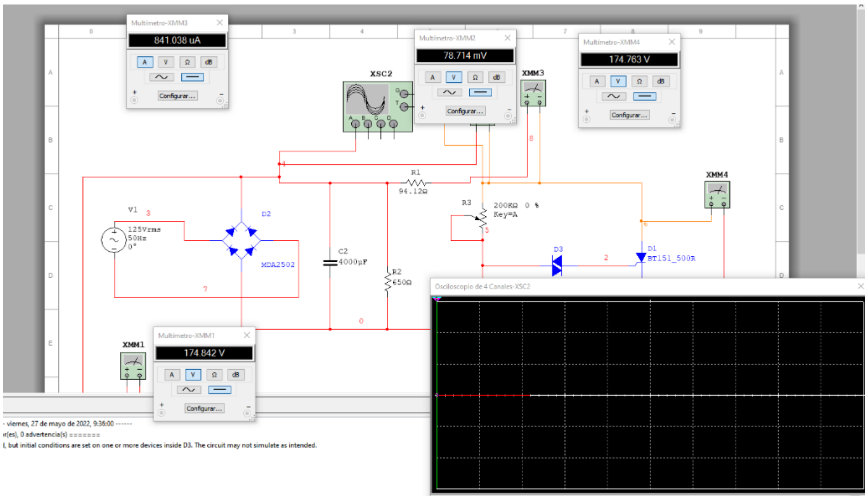
2. Esquema amb Multisim


3
V1
125Vrms
50Hz
0°
D2
MDA2502
7
4
C2
4000µF
R1
94.12Ω
R2
650Ω
6
R3
200KΩ 100 %
Key=A
5
D3
ECG6408
C1
100nF
2
D1
BT151_500R
0

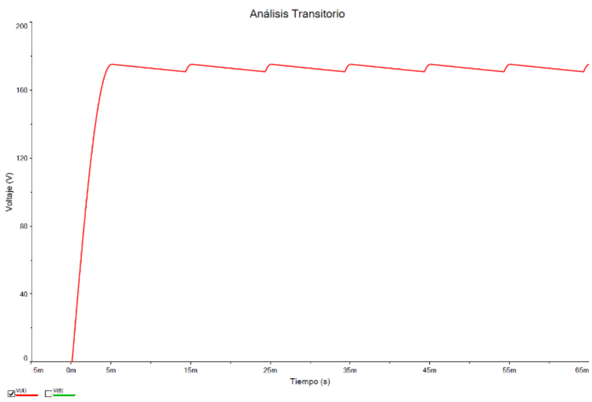
- Simulació:



Com es pot observar amb el potenciòmetre al 100% tenim 167V a la resistència del induït amb una corrent de 1,77A i 135mV en el tiristor. També tenim un voltatge de riçat molt petit com es pot veure en el oscil·loscopi.



En posar el potenciòmetre al 0 aquest deixa un voltatge de 78mV a la resistència del induït amb una corrent de 841uA i 174V al tiristor.



3. Components

- Transformador 230VAC - 125VAC Monofàsic 500VA AT-500

- Pont de díodes d'ona complerta monofàsic MDA2502 Motorola de 200V i 25A.
- Tiristor 2N1774 de 200V i 4,7A deixant el 200% de seguretat en la intensitat.
- Condensador 101C402T200EE2B de 200V i 4000uF
- Dissipador hs14-1852840 de 2ºC/W.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MDA2500 Series

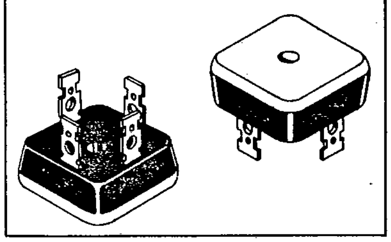
RECTIFIER ASSEMBLY

. . . utilizing individual void-free molded rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

- 400 Ampere Surge Capability
- Electrically Isolated Base
- UL Recognized
- 1800 Volt Heat Sink Isolation

SINGLE-PHASE FULL-WAVE BRIDGE

25 AMPERES
50-600 VOLTS



MAXIMUM RATINGS

Rating (Per Diode)	Symbol	MDA 2500	2501	2502	2504	2506	2508	2510	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
DC Output Voltage Resistive Load Capacitive Load	Vdc	30 50	62 100	124 200	250 400	380 600	500 600	620 1000	Volts
Sine Wave RMS Input Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, $T_C = 55°C$)	I_O	25							Amp
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	400							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175							°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Case Each Die Total Bridge	$R_{\theta JC}$	 4.5 2.0	 6.0 2.8	°C/W

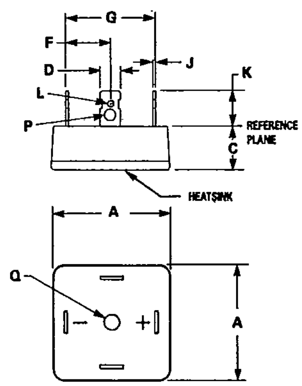
ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (Per Diode) ($i_F = 40$ A)*	v_F	—	0.95	1.05	Volts
Reverse Current (Per Diode) (Rated V_R)	I_R	—	—	10	μA

MECHANICAL CHARACTERISTICS

CASE: Plastic case with an electrically isolated aluminum base.
POLARITY: Terminal designation embossed on case:
+DC output
−DC output
AC not marked
MOUNTING POSITION: Bolt down. Highest heat transfer efficiency accomplished through the surface opposite the terminals. Use silicone heat sink compound on mounting surface for maximum heat transfer.
WEIGHT: 25 grams (approx.)
TERMINALS: Suitable for fast-on connections. Readily solderable, corrosion resistant. Soldering recommended for applications greater than 15 amperes.
MOUNTING TORQUE: 20 in-lb max

*Pulse Width = 100 ms, Duty Cycle ≤ 2%.



NOTES:
1. DIMENSION "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PACKAGE.
2. DIMENSIONS "F" AND "G" SHALL BE MEASURED AT THE REFERENCE PLANE.

DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	25.65	26.16	1.010	1.030
C	12.44	13.97	0.490	0.550
D	6.10	6.60	0.240	0.260
F	10.01	10.49	0.394	0.413
G	19.99	21.01	0.787	0.827
J	0.71	0.86	0.028	0.034
K	9.52	11.43	0.375	0.450
L	1.52	2.06	0.060	0.081
P	2.79	2.92	0.110	0.115
Q	4.42	4.67	0.174	0.184

CASE 309A-03

MDA2500 Series

FIGURE 1 – FORWARD VOLTAGE

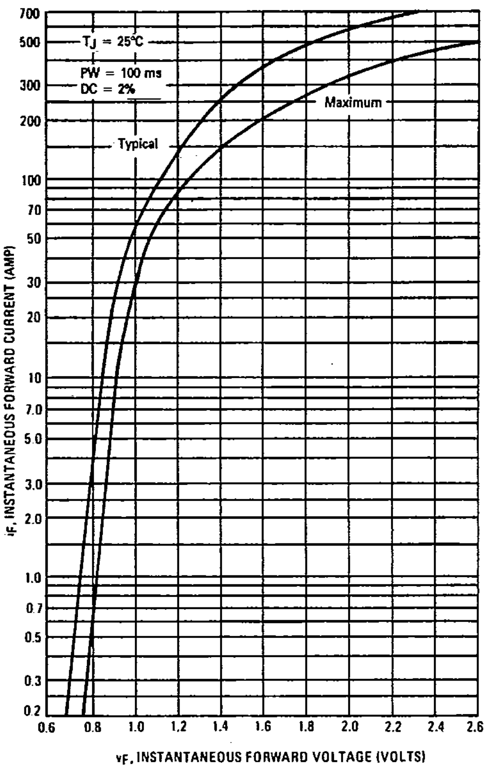


FIGURE 2 – NON REPETITIVE SURGE CURRENT

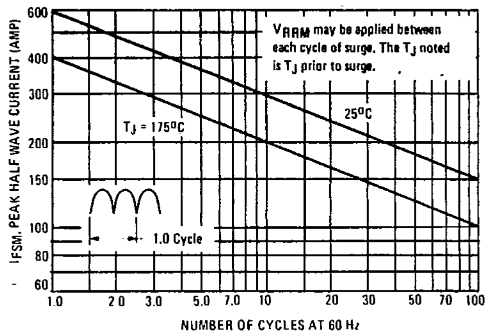


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

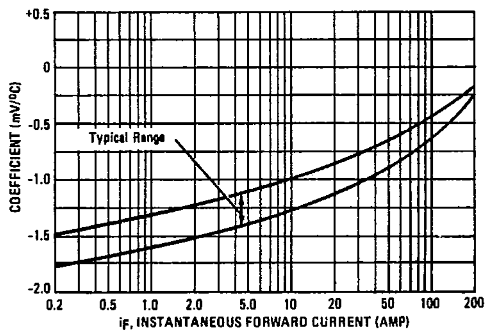


FIGURE 4 – CURRENT DERATING

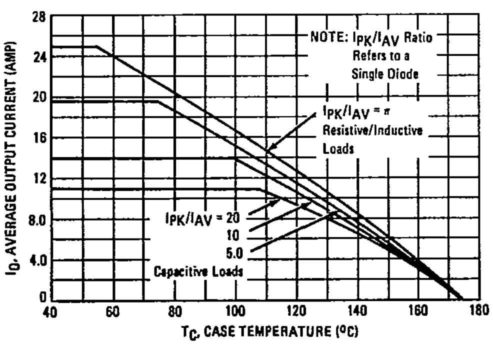


FIGURE 5 – FORWARD POWER DISSIPATION

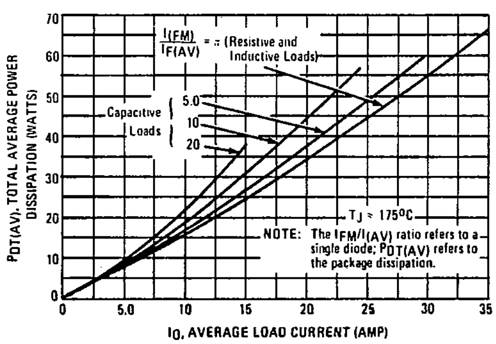
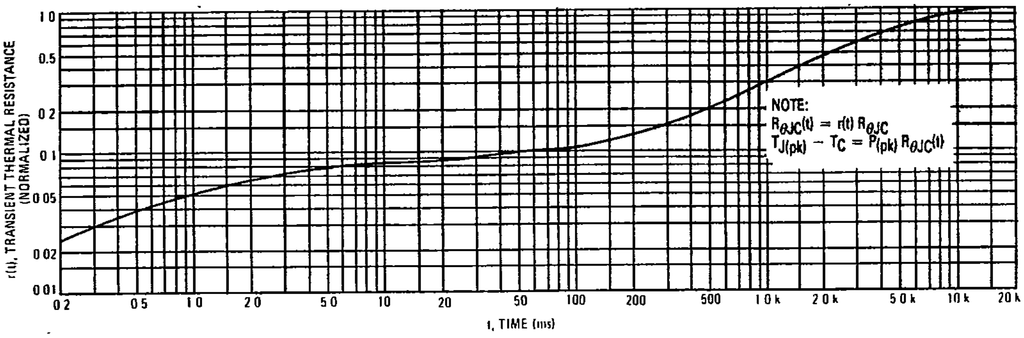
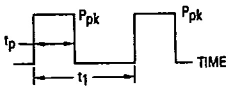


FIGURE 6 — TYPICAL THERMAL RESPONSE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse.

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended.

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1). The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature. It may be determined by:

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i.e.,
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$.

FIGURE 7 — CAPACITANCE

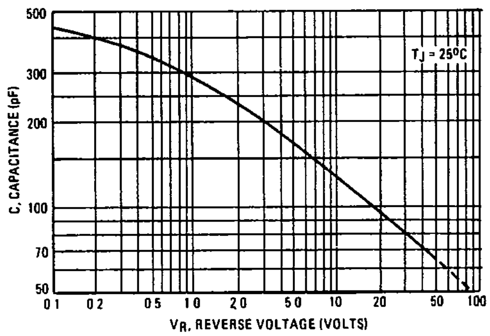


FIGURE 8 — FORWARD RECOVERY TIME

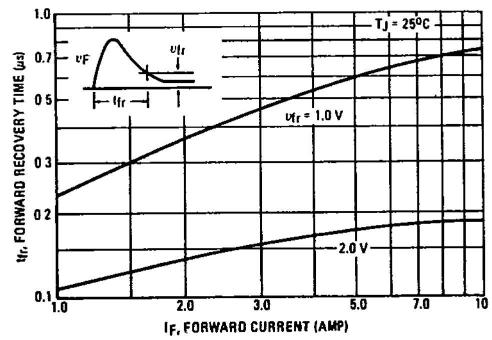
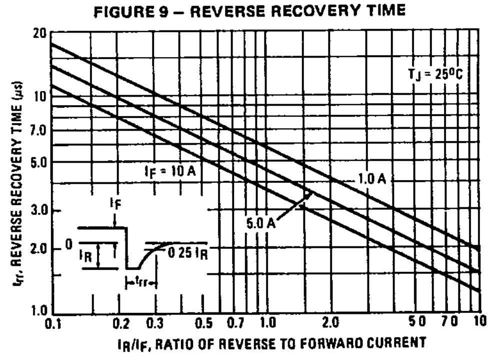


FIGURE 9 — REVERSE RECOVERY TIME



3

AMBIENT TEMPERATURE DERATING INFORMATION

FIGURE 10A — THERMALLOY HEAT SINK 6005B

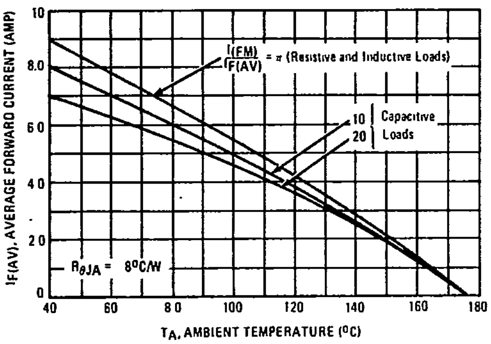
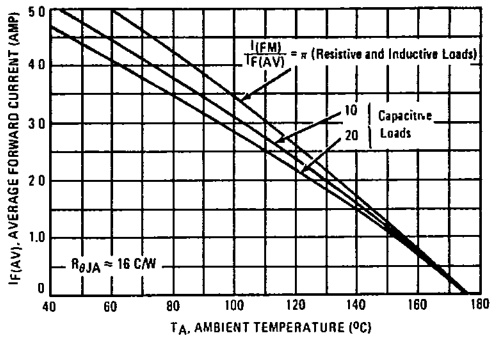


FIGURE 10B — IERC HEAT SINK UP3



NOTE 2: THERMAL COUPLING AND EFFECTIVE THERMAL RESISTANCE

In multiple chip devices where there is coupling of heat between die, the junction temperature can be calculated as follows:

(1) $\Delta T_{J1} = R_{\theta 1}P_{D1} + R_{\theta 2}K_{\theta 2}P_{D2} + R_{\theta 3}K_{\theta 3}P_{D3} + R_{\theta 4}K_{\theta 4}P_{D4}$

where ΔT_{J1} is the change in junction temperature of diode 1, $R_{\theta 1}$ through 4 is the thermal resistance of diodes 1 through 4, P_{D1} through 4 is the power dissipated in diodes 1 through 4, $K_{\theta 2}$ through 4 is the thermal coupling between diode 1, and diodes 2 through 4.

An effective package thermal resistance can be defined as follows:

$$(2)\quad R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$$

where P_{DT} is the total package power dissipation.

Assuming equal thermal resistance for each die, equation (1) simplifies to

$$(3)\quad \Delta T_{J1} = R_{\theta 1}(P_{D1} + K_{\theta 2}P_{D2} + K_{\theta 3}P_{D3} + K_{\theta 4}P_{D4})$$

For the conditions where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4\,P_{D1}$, equation (3) can be further simplified and by substituting into equation (2) results in

$$(4)\quad R_{\theta(EFF)} = R_{\theta 1}(1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4})/4$$

When the case is used as a reference point, coupling between opposite die is negligible for the MDA2500, and coupling between adjacent die is approximately 6%.

NOTE 3: SPLIT LOAD DERATING INFORMATION

Bridge rectifiers are used in two basic configurations as shown by circuits A and B of Figure 11. The current derating data of Figure 4 applies to the standard bridge circuit (A) where $I_A = I_B$. For circuit B where $I_A \neq I_B$, derating information can be calculated as follows:

$$(6)\quad T_{R(max)} = T_{J(max)} - \Delta T_{J1}$$

Where $T_{R(max)}$ is the reference temperature (either case or ambient), ΔT_{J1} can be calculated using equation (3) in Note 2.

For example, to determine $T_{C(max)}$ for the MDA2500 with the following capacitive load conditions:

I_A = 20 A average with a peak of 60 A,
I_B = 10 A average with a peak of 70 A,

first calculate the peak to average ratio for I_A. $I_{(PK)}/I_{(AV)}$ = 60/10 = 6.0. (Note that the peak to average ratio is on a per diode basis and each diode provides 10 A average.)

From Figure 5, for an average current of 20 A and an $I_{(PK)}/I_{(AV)}$ = 6.0, read $P_{DT(AV)}$ = 40 watts or 10 watts/diode. Thus $P_{D1} = P_{D3}$ = 10 watts.

Similarly, for a load current I_B of 10 A, diode #2 and diode #4 each see 5.0 A average resulting in an $I_{(PK)}/I_{(AV)}$ = 14. Thus, the package power dissipation for 10 A is 20 watts or 5.0 watts/diode. Therefore, $P_{D2} = P_{D4}$ = 5.0 watts.

The maximum junction temperature occurs in diodes #1 and #3. From equation (3) for diode #1,

$$\Delta T_{J1} = 10[10 + 0(5) + 0.06(10) + 0.06(5)]$$
$$\Delta T_{J1} \approx 109°C.$$

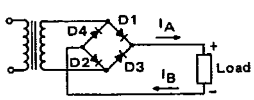
Thus, $T_{C(max)}$ = 175 − 109 = 66°C.

The total package dissipation in this example is

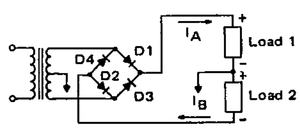
$$P_{DT(AV)} = 2 \times 10 + 2 \times 5.0 = 30 \text{ watts},$$

which must be considered when selecting a heat sink.

FIGURE 11 — BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS



Circuit A



Circuit B

DIGITRON™ Semiconductors

High-reliability discrete products
and engineering services since 1977

2N1770-2N1778, 2N2619

PHASE CONTROL SCR

FEATURES

- Available as "HR" (high reliability) screened per MIL-PRF-19500, JANTX level. Add "HR" suffix to base part number.
- Available as non-RoHS (Sn/Pb plating), standard, and as RoHS by adding "-PBF" suffix.

MAXIMUM RATINGS

Ratings	Symbol	2N1770	2N1771	2N1772	2N1773	2N1774	Units
Repetitive peak off-state voltage	V_{DRM}	25	50	100	150	200	Volts
Repetitive peak reverse voltage	V_{RRM}	25	50	100	150	200	Volts
Non-repetitive peak reverse voltage	V_{RSM}	40	75	150	225	300	Volts

Ratings	Symbol	2N1775	2N1776	2N1777	2N1778	2N2619	Units
Repetitive peak off-state voltage	V_{DRM}	250	300	400	500	600	Volts
Repetitive peak reverse voltage	V_{RRM}	250	300	400	500	600	Volts
Non-repetitive peak reverse voltage	V_{RSM}	350	400	500	600	720	Volts

Ratings	Symbol	2N1770-2N1778, 2N2619	Units
RMS on-state current	$I_{T(RMS)}$	7.4	Amps
Average on-state current (nominal) T_C = 60°C	$I_{T(AV)}$	4.7	Amps
Peak one-cycle surge (non-repetitive) on-state current (60 Hz)	I_{TSM}	60	Amps
Peak one-cycle surge (non-repetitive) on-state current (50 Hz)	I_{TSM}	52	Amps
Critical rate of rise of on-state current (repetitive)	di/dt	40	A/µs
I^2t (for fusing), 8.3ms	I^2t	15	A^2sec
Peak gate power dissipation	P_{GM}	5	Watts
Average gate power dissipation	$P_{G(AV)}$	0.5	Watts
Peak forward gate voltage	V_{FGM}	10	Volts
Peak forward gate current	I_{FGM}	2	Amps
Peak reverse gate voltage	V_{RGM}	10	Volts
Storage temperature	T_{stg}	-65 to +150	°C
Operating temperature	T_J	-65 to +125	°C
Mounting torque	-	15	Inch-pounds
Mounting torque	-	17.5	kg-cm

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified)

Characteristics	Symbol	Test Conditions	2N1770	2N1771	2N1772	2N1773	2N1774	Units
Voltage-Blocking state maximum Forward leakage, peak	I_{DRM}	T_J = 125°C, $V_D = V_{DRM}$	9.0	9.0	9.0	8.0	6.0	mA
Reverse leakage, peak	I_{RRM}	T_J = 125°C, $V_R = V_{RRM}$	9.0	9.0	9.0	8.0	6.0	mA

Characteristics	Symbol	Test Conditions	2N1775	2N1776	2N1777	2N1778	2N2619	Units
Voltage-Blocking state maximum Forward leakage, peak	I_{DRM}	T_J = 125°C, $V_D = V_{DRM}$	5.0	4.0	2.0	2.0	2.0	mA
Reverse leakage, peak	I_{RRM}	T_J = 125°C, $V_R = V_{RRM}$	5.0	4.0	2.0	2.0	2.0	mA

2N1770-2N1778, 2N2619

PHASE CONTROL SCR

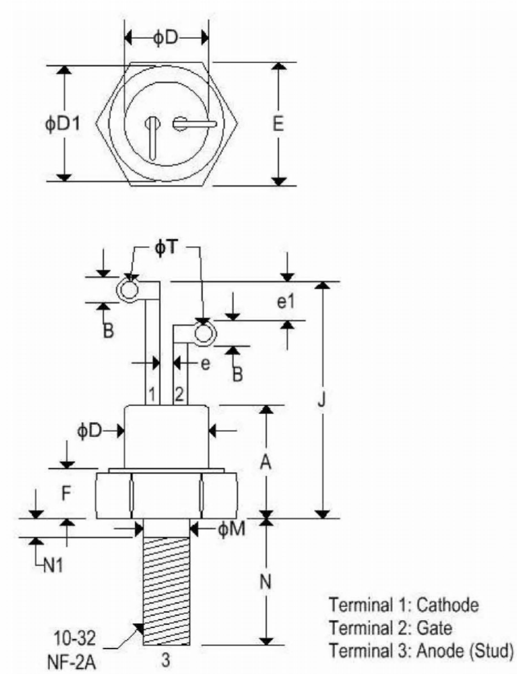
Digitron Semiconductors

High-reliability discrete products and engineering services since 1977

Characteristics	Symbol	Test Conditions	2N1770-2N1778, 2N2619			Units
			Min	Typ	Max	
Current- Conducting state Holding current	I_H	V_D = 6V, T_J = 25°C	-	8.0	-	mA
Peak on state voltage	V_{TM}	T_J = 25°C, I_{TM} = 15A	-	1.6	1.85	Volts
Switching Turn-off time	t_q	T_J = 125°C Reapplied dv/dt = 20V/µs	-	15	-	µs
Turn-on time	t_{on}	Gate supply: 7V, 20 Ω 0.1 µs rise time	-	1.0	-	µs
Typical critical dv/dt exponential to V_{DRM}	dv/dt	-	-	20	-	V/µs
Thermal Maximum thermal resistance, Junction to case	$R_{th(j-c)}$	-	-	1.5	3.1	°C/Watt
Gate- Maximum parameters Gate current to trigger	I_{GT}	V_D = 12V, R_L = 250Ω, T_J = -65°C V_D = 12V, R_L = 250Ω, T_J = 125°C V_D = 12V, R_L = 250Ω, T_J = 25°C	- - -	20 4 10	30 8 15	mA
Gate voltage to trigger	V_{GT}	V_D = 12V, R_L = 250Ω, T_J = 25°C	-	1.3	2.0	Volts
Non-triggering gate voltage	V_{GD}	V_D= V_{DRM}, R_L = 250Ω, T_J = 125°C	0.3	0.7	-	Volts

MECHANICAL CHARACTERISTICS

Case:	TO-64
Marking:	Alpha-numeric
Polarity	Anode is stud



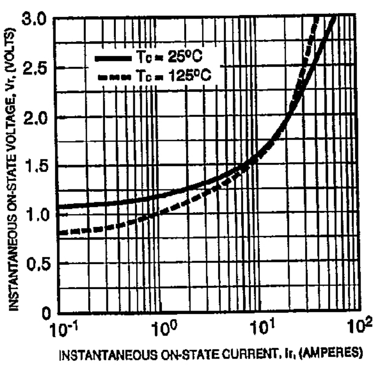
	TO-64			
	Inches		Millimeters	
	Min	Max	Min	Max
A	0.300	0.410	7.620	10.414
B	0.080	0.140	2.030	3.556
ΦD	-	0.424	-	10.770
$ΦD_1$	0.400	-	10.160	-
E	0.424	0.437	10.770	11.100
e	0.013	-	0.330	-
e_1	0.060	-	1.520	-
F	0.060	0.175	1.520	4.450
J	0.700	0.855	17.780	21.720
ΦM	0.163	0.189	4.140	4.800
N	0.400	0.453	10.160	11.510
N_1	-	0.078	-	1.980
ΦT	0.040	0.075	1.020	1.910

High-reliability discrete products
and engineering services since 1977

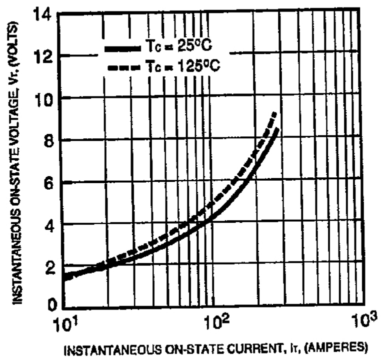
2N1770-2N1778, 2N2619

PHASE CONTROL SCR

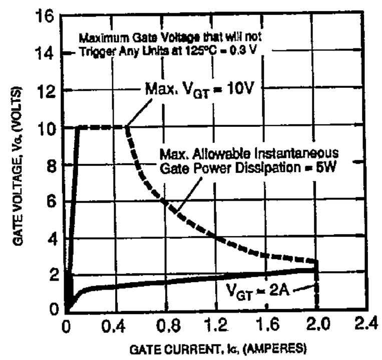
MAXIMUM ON-STATE CHARACTERISTICS



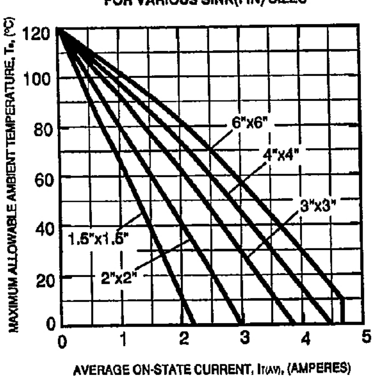
MAXIMUM ON-STATE CHARACTERISTICS (HIGH LEVEL)



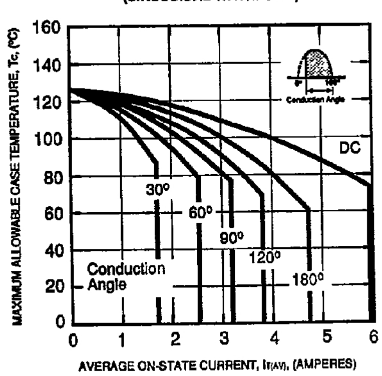
GATE CHARACTERISTICS



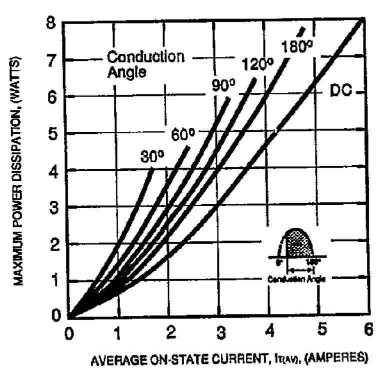
MAXIMUM ALLOWABLE AMBIENT TEMPERATURE FOR VARIOUS SINK(FIN) SIZES



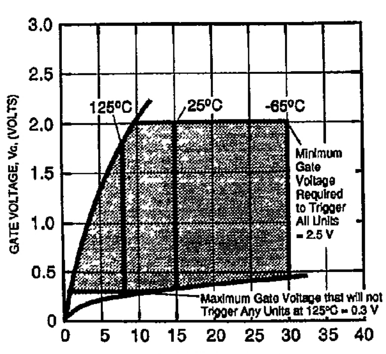
MAXIMUM ALLOWABLE CASE TEMPERATURE (SINUSOIDAL WAVEFORM)



MAXIMUM ON-STATE POWER DISSIPATION (SINUSOIDAL WAVEFORM)



MINIMUM GATE CURRENT REQUIRED TO TRIGGER ALL DEVICES



click here to see hardware and mounting options

Type 101C –55 °C to 105 °C Low-ESR, Wide-Temperature Grade

The Ultimate in Cold Performance and ESR
The Type 101C is the wide-temperature, low voltage version of the Type 550C. It is ideal for high-ripple current military and industrial applications that need full performance to –40 ºC and solid performance to –55 ºC. It also excels as a power-supply output capacitor because of its exceptionally low ESR. The extended cathode foil of the 101C assures heat flow from the capacitor element to the can in all mounting orientations.

Highlights

- 5,000 hour load life
- Ripple Current to > 100 amps @ 55 °C
- ESRs to 2.5 mΩ
- > 90% capacitance at –40 ºC
- Thermal-Pak™ extended cathode construction

Specifications

Temperature Range	–55 °C to +105 °C
Rated Voltage Range	7.5 to 250 Vdc
Capacitance Range	290 µF to 1.5 F
Capacitance Tolerance	7.5 to 150 Vdc: –10% +75%, 200 & 250 Vdc: –10% +50%
Leakage Current	≤1.5 $\sqrt{CV}$ µA, 4 mA max, 5 minutes
Ripple Current Multipliers	Ambient Temperature

45 ºC	55 ºC	65 ºC	75 ºC	85 ºC	95 ºC	105 ºC
1.66	1.52	1.37	1.20	1.00	0.75	0.36

Frequency	50 Hz	60 Hz	120 Hz	360 Hz	1 kHz	5 kHz	10 kHz & up
1 3/8″ & 1 3/4″ Diameters							
7.5 to 150 V	0.91	0.93	1.00	1.06	1.08	1.09	1.09
200 & 250 V	0.82	0.86	1.00	1.14	1.20	1.23	1.23
2″ & 2 1/2″ Diameters							
7.5 to 150 V	0.92	0.94	1.00	1.05	1.07	1.08	1.08
200 & 250 V	0.82	0.86	1.00	1.14	1.20	1.23	1.27
3″ Diameters							
7.5 to 150 V	0.95	0.96	1.00	1.03	1.04	1.05	1.05
200 & 250 V	0.85	0.88	1.00	1.11	1.15	1.18	1.18

Low Temperature Characteristics	Impedance ratio: $Z_{-55ºC}/Z_{+25ºC} \leq 3$
Endurance Life Test	5,000 h at 105 °C and full load ∆Capacitance ±20% ESR 200% of limit DCL 100% of limit
Shelf Life Test	500 h at 105 °C Capacitance 100% of limit ESR 100% of limit DCL 100% of limit
Vibration	10 to 55 Hz, 0.06″ and 10 g max, 1.5 h each of two axis
RoHS Compliant	

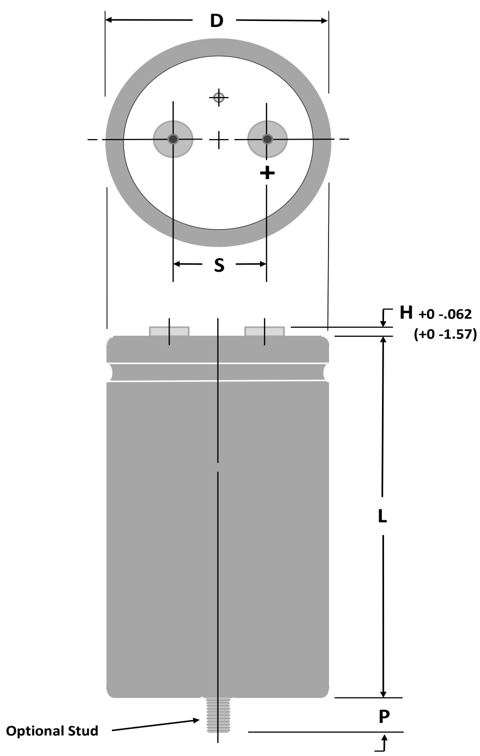
Type 101C –55 °C to 105 °C Low-ESR, Wide-Temperature Grade

Part Numbering System

101C	183	T	250	DG	2	D	S
Type	Capacitance	Tolerance	Voltage	Case Code	Insulation	Terminal	Can Style
	100 = **10 µF** **101** = 100 µF **183** = 18,000 µF	**M** = ±20% **U** = –10%+75% **T** = –10%+50%	**250** = 250 Vdc		**0**= None **1**= Polyester **2**= PVC	**A** = Low Post **B** = High Post **D** = High Current	**Blank**= Standard Can **S**= Stud Bottom **P**= Stud with Thermal Pad

Standard insulation is 0.008-in PVC sleeve with 0.01-in polypropylene end disk.

Outline Drawing



Stud Dimensions

Case Diam.	Stud Thread	P± 0.039″ (±1.0 mm)
1.375	M8	0.470″ (12.0)
1.750	M8	0.470″ (12.0)
2.000	M12	0.630″ (16.0)
2.500	M12	0.630″ (16.0)
3.000	M12	0.630″ (16.0)

NOTE: With the stud-mount feature, a thermally-conductive disk can be inserted in the bottom flush with the outer insulating sleeve. This reduces the thermal resistance through the can bottom by 0.3 °C/W. Can Style P.

Terminal Dimensions

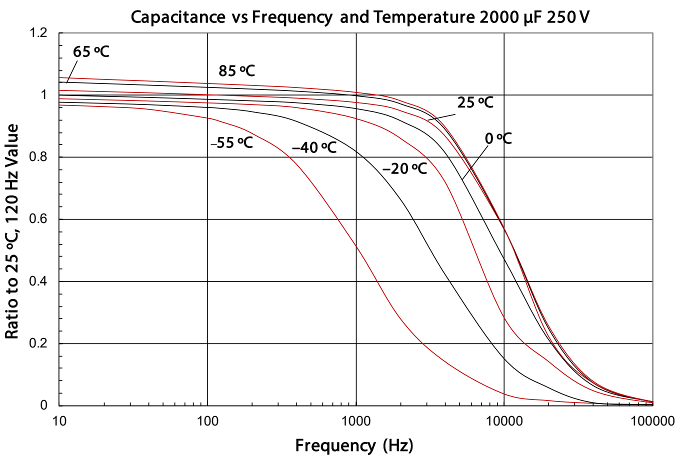
	For Case		Post Diameter		H max			min Full Thread		Torque	
Terminal Style	Diameters	Code	in	mm	in	mm	Thread	in	mm	in·lb	N·m
Low Post	1⅜ to 3	A	0.314	8.0	0.094	2.4	10–32	0.218	5.5	25	2.82
High Post	1⅜ to 3	B	0.314	8.0	0.281	7.1	10–32	0.375	9.5	25	2.82
High Current, Med	2½ to 3	D	0.434	11.0	0.190	4.8	¼–28	0.312	7.9	50	5.65

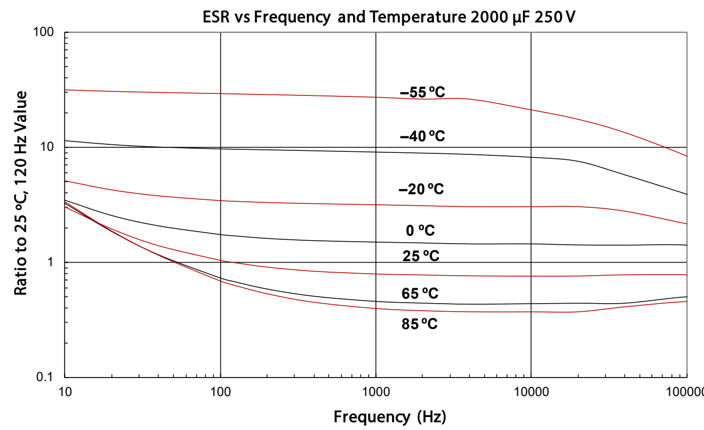
Type 101C –55 °C to 105 °C Low-ESR, Wide-Temperature Grade

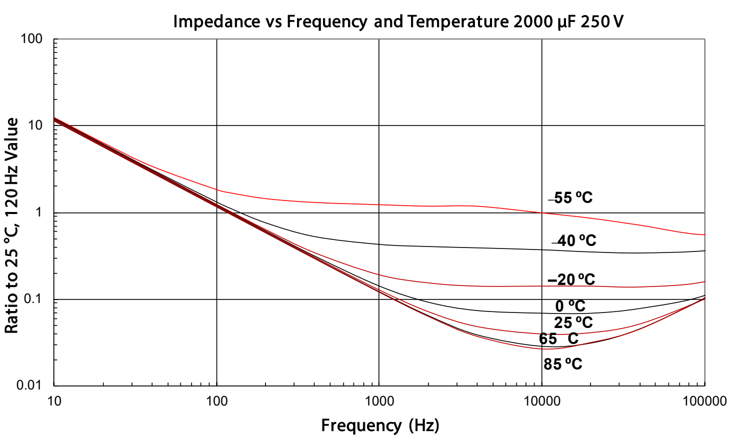
Cap. (µF)	Catalog Part Number	ESR Max @ 25 °C 120 Hz (mΩ)	Ripple Max @ 85 °C 120 Hz (A)	Nominal Size D x L (in)
		200 Vdc (275 Vdc Surge)		
380	101C381T200AK2B	453.7	2.0	1 3/8 x 1 5/8
680	101C681T200AA2B	253.5	3.0	1 3/8 x 2 1/8
890	101C891T200EA2B	223.5	3.7	1 3/4 x 2 1/8
980	101C981T200AH2B	175.9	3.9	1 3/8 x 2 5/8
1,100	101C112T200BA2B	180.9	4.5	2 x 2 1/8
1,300	101C132T200AB2B	132.6	4.8	1 3/8 x 3 1/8
1,400	101C142T200EH2B	142.1	5.0	1 3/4 x 2 5/8
1,600	101C162T200AJ2B	107.8	5.6	1 3/8 x 3 5/8
1,800	101C182T200BH2B	110.5	6.1	2 x 2 5/8
1,900	101C192T200EB2B	104.7	6.2	1 3/4 x 3 1/8
1,900	101C192T200AC2B	88.9	6.4	1 3/8 x 4 1/8
2,200	101C222T200AD2B	90.4	6.7	1 3/8 x 4 5/8
2,400	101C242T200EJ2B	82.9	7.3	1 3/4 x 3 5/8
2,400	101C242T200BB2B	82.9	7.5	2 x 3 1/8
2,500	101C252T200AE2B	79.6	7.4	1 3/8 x 5 1/8
2,800	101C282T200AF2B	71.0	8.1	1 3/8 x 5 5/8
3,100	101C312T200BJ2B	64.2	9.0	2 x 3 5/8
3,400	101C342T200EC2B	58.5	9.1	1 3/4 x 4 1/8
3,500	101C352T200ED2B	56.8	9.7	1 3/4 x 4 5/8
4,000	101C402T200EE2B	49.7	10.7	1 3/4 x 5 1/8
4,000	101C402T200CB2B	49.7	11.2	2 1/2 x 3 1/8
4,000	101C402T200BC2B	43.1	11.5	2 x 4 1/8
4,400	101C442T200BD2B	45.2	11.7	2 x 4 5/8
4,500	101C452T200EF2B	44.2	11.7	1 3/4 x 5 5/8
5,000	101C502T200BE2B	39.8	12.9	2 x 5 1/8
5,100	101C512T200CJ2B	39.0	13.3	2 1/2 x 3 5/8
6,100	101C612T200BF2B	32.6	14.7	2 x 5 5/8
6,500	101C652T200CC2B	26.3	16.9	2 1/2 x 4 1/8
7,200	101C722T200CH2B	27.6	14.1	2 1/2 x 2 5/8
7,200	101C722T200CD2B	27.6	17.1	2 1/2 x 4 5/8
7,600	101C762T200DJ2B	29.7	17.0	3 x 3 5/8
8,300	101C832T200CE2B	24.0	19.0	2 1/2 x 5 1/8
9,300	101C932T200DC2B	21.4	20.9	3 x 4 1/8
10,000	101C103T200CF2B	21.2	20.8	2 1/2 x 5 5/8
11,000	101C113T200DD2B	20.5	22.1	3 x 4 5/8
13,000	101C133T200DB2B	17.8	20.9	3 x 3 1/8
13,000	101C133T200DE2B	17.8	24.5	3 x 5 1/8
14,000	101C143T200DF2B	16.9	25.9	3 x 5 5/8
15,000	101C153T200DP2B	15.9	27.1	3 x 5 7/8
20,000	101C203T200DN2D	12.5	33.9	3 x 7 5/8
23,000	101C233T200DG2D	10.4	37.8	3 x 8 5/8

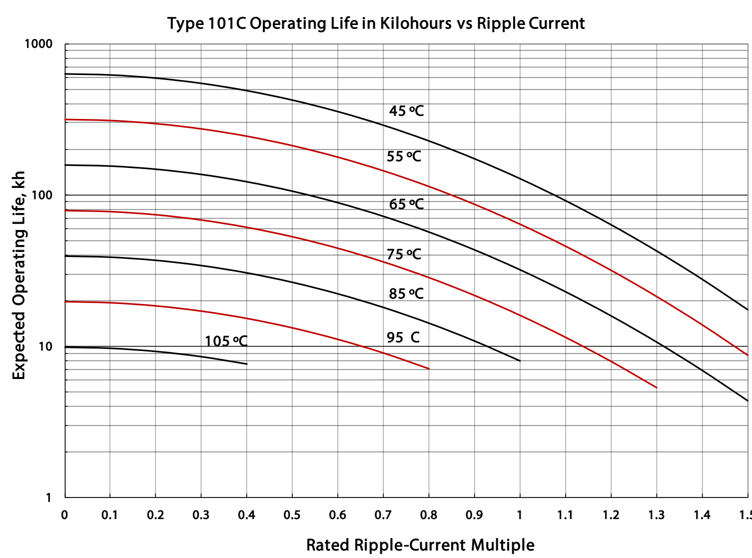
Cap. (µF)	Catalog Part Number	ESR Max @ 25 °C 120 Hz (mΩ)	Ripple Max @ 85 °C 120 Hz (A)	Nominal Size D x L (in)
		250 Vdc (350 Vdc Surge)		
290	101C291T250AK2B	548.8	1.8	1 3/8 x 1 5/8
530	101C531T250AA2B	300.3	2.7	1 3/8 x 2 1/8
700	101C701T250EA2B	227.4	3.7	1 3/4 x 2 1/8
760	101C761T250AH2B	209.4	3.5	1 3/8 x 2 5/8
890	101C891T250BA2B	163.9	4.7	2 x 2 1/8
990	101C991T250AB2B	160.8	4.3	1 3/8 x 3 1/8
1,100	101C112T250EH2B	144.7	5.0	1 3/4 x 2 5/8
1,200	101C122T250AJ2B	132.6	5.0	1 3/8 x 3 5/8
1,400	101C142T250BH2B	104.2	6.3	2 x 2 5/8
1,500	101C152T250AC2B	106.1	5.9	1 3/8 x 4 1/8
1,500	101C152T250EB2B	106.1	6.2	1 3/4 x 3 1/8
1,700	101C172T250AD2B	101.4	6.3	1 3/8 x 4 5/8
1,900	101C192T250AE2B	90.7	6.9	1 3/8 x 5 1/8
1,900	101C192T250EJ2B	83.8	7.3	1 3/4 x 3 5/8
1,900	101C192T250BB2B	69.8	8.2	2 x 3 1/8
2,200	101C222T250AF2B	84.4	7.4	1 3/8 x 5 5/8
2,300	101C232T250CH2B	75.0	8.6	2 1/2 x 2 5/8
2,300	101C232T250EC2B	69.2	8.4	1 3/4 x 4 1/8
2,400	101C242T250BJ2B	58.0	9.5	2 x 3 5/8
2,700	101C272T250ED2B	58.9	9.5	1 3/4 x 4 5/8
2,900	101C292T250BC2B	50.3	10.7	2 x 4 1/8
3,100	101C312T250CB2B	55.6	10.6	2 1/2 x 3 1/8
3,100	101C312T250EE2B	51.3	10.5	1 3/4 x 5 1/8
3,400	101C342T250BD2B	45.6	11.7	2 x 4 5/8
3,500	101C352T250EF2B	45.5	11.6	1 3/4 x 5 5/8
3,900	101C392T250BE2B	42.0	12.6	2 x 5 1/8
4,000	101C402T250CJ2B	43.1	12.6	2 1/2 x 3 5/8
4,500	101C452T250BF2B	38.3	13.6	2 x 5 5/8
4,700	101C472T250DB2B	42.3	13.6	3 x 3 1/8
5,100	101C512T250CC2B	30.6	15.6	2 1/2 x 4 1/8
5,700	101C572T250CD2B	28.9	16.7	2 1/2 x 4 5/8
5,900	101C592T250DJ2B	33.7	16.0	3 x 3 5/8
6,500	101C652T250CE2B	26.6	18.0	2 1/2 x 5 1/8
7,200	101C722T250DC2B	27.6	18.4	3 x 4 1/8
7,700	101C772T250CF2B	24.1	19.5	2 1/2 x 5 5/8
8,500	101C852T250DD2B	23.4	20.7	3 x 4 5/8
9,700	101C972T250DE2B	20.5	22.8	3 x 5 1/8
11,000	101C113T250DF2B	18.1	25.0	3 x 5 5/8
12,000	101C123T250DP2B	16.6	26.5	3 x 5 7/8
16,000	101C163T250DN2D	13.4	32.8	3 x 7 5/8
18,000	101C183T250DG2D	11.1	36.7	3 x 8 5/8

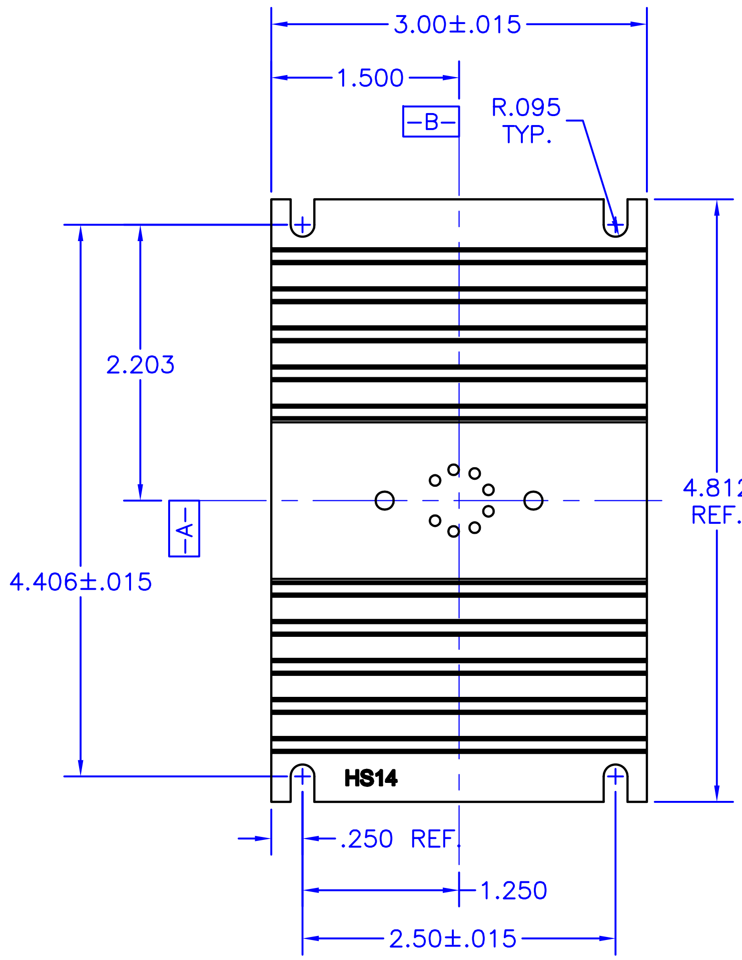
Typical Performance Curves

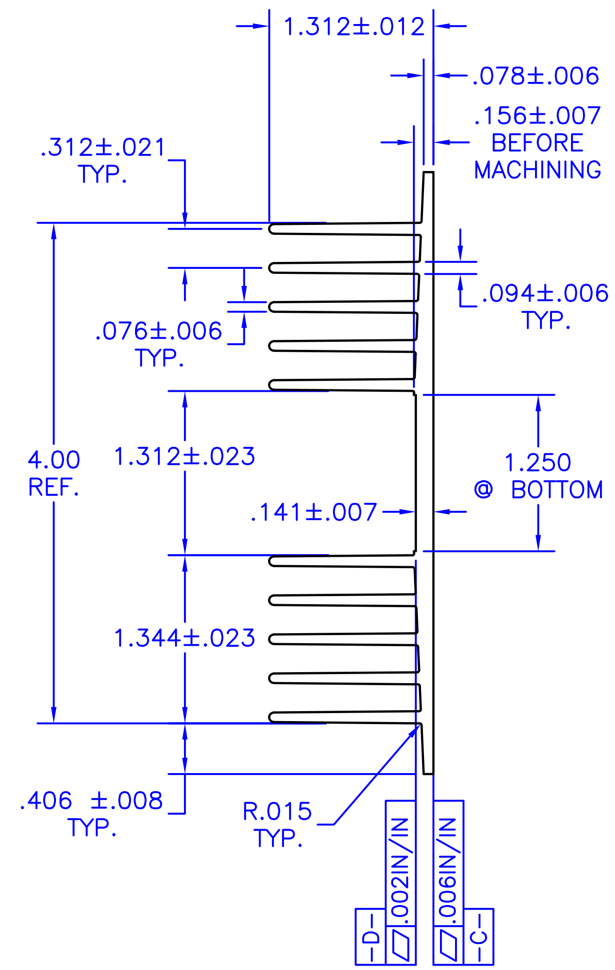


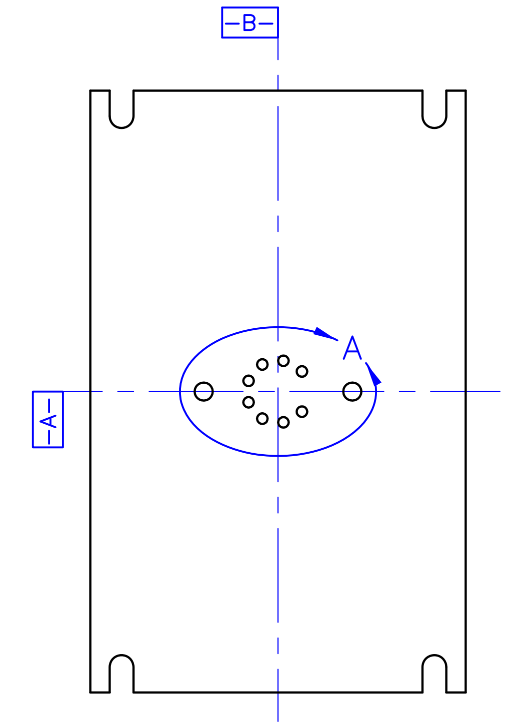


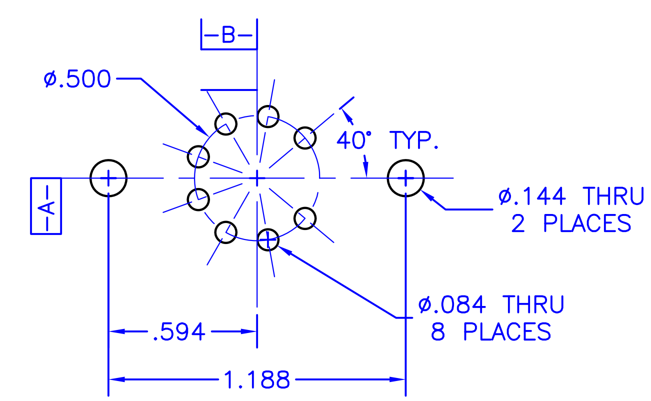




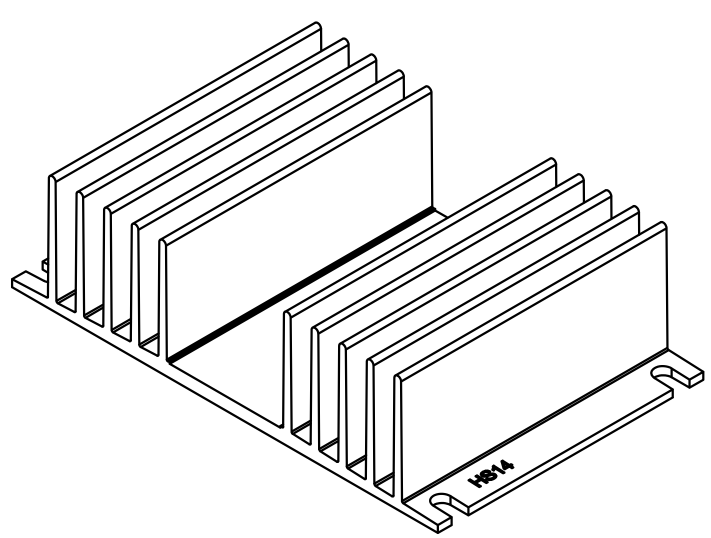








DETAIL A
SCALE: 2X



P1 **HEATSINK**

MAT'L: 6063–T5 ALUMINUM (AAVID EXTRUSION #60840)
FINISH: ANODIZE PER MIL–A–8625, TYPE II, CL 2, BLACK
TYPICAL BREAKDOWN VOLTAGE > 300V

NOTES:

1. UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE IN INCHES.
2. BREAK ALL SHARP EDGES, DE–BURR & REMOVE LOOSE CHIPS.
3. MARK WITH CONTRASTING INK AS SHOWN, IF SPECIFIED BY PURCHASE ORDER.
4. THERMAL RATING: 2 °C/W
5. APPROXIMATE WEIGHT: 7.5 oz [213g]

TOLERANCES - UNLESS OTHERWISE SPECIFIED	APEX MICROTECHNOLOGY	TITLE: TO-3 HEATSINK	MODEL: HS14
.XX = ±.01 [.254]		SUBJECT: MECHANICAL DRAWING	
.XXX = ±.005 [.127]		ENGINEER: D-M · DRAWN BY: R.MOR · DCA: 13497 · SH. 1 OF 1	FILENAME: HS14 · REV: I · DATE: 03JAN14
ANG. = ±5°			