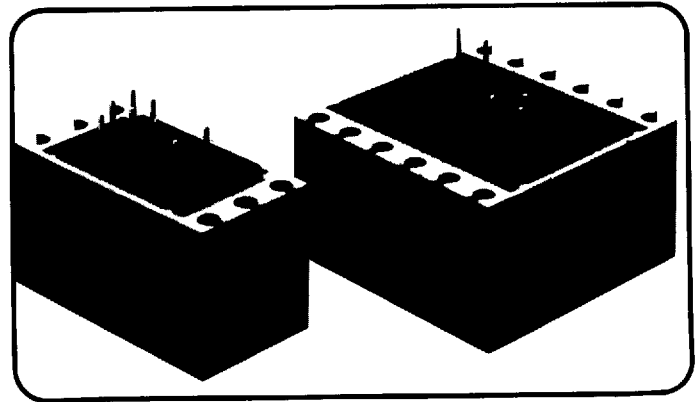


TR, TRC, TD Transformer Isolated Output Modules

Features:

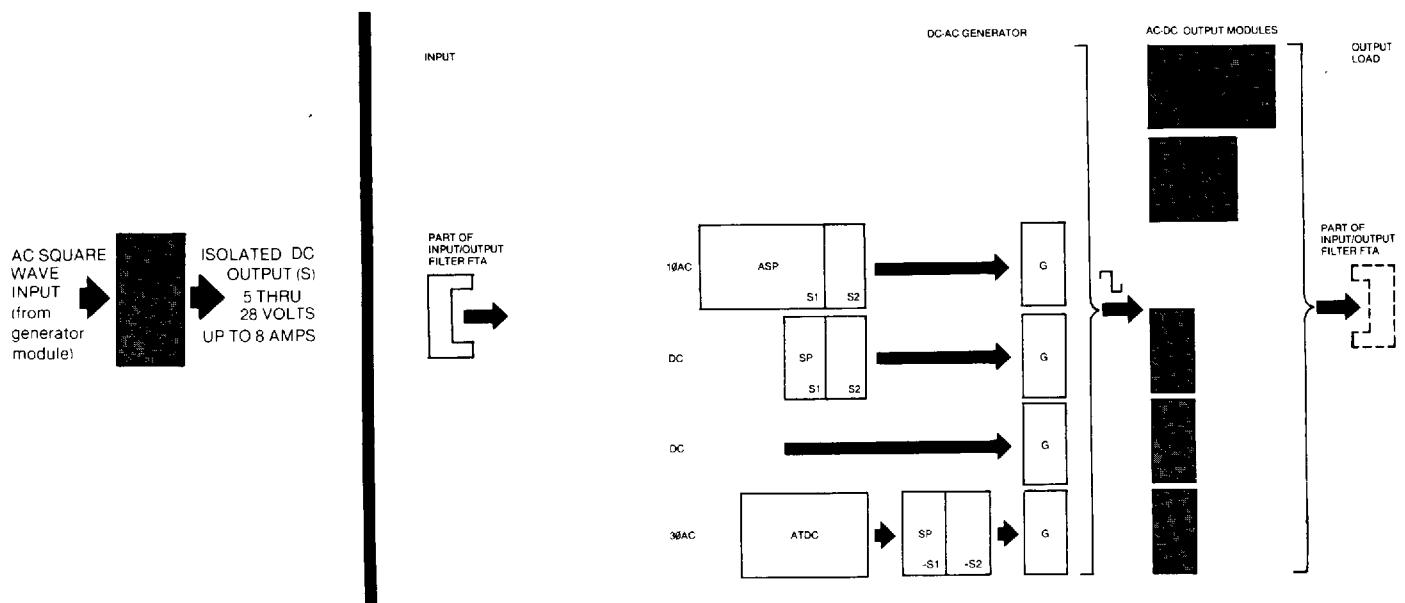
- Outputs from 5 to 28VDC
- Overcurrent Protected (fold-back)-TR & TRC only
- Overvoltage Protected
- Full Performance from -55°C to $+100^{\circ}\text{C}$
- All outputs isolated



Transformer Isolated Output Modules

The TR, TRC & TD series of output modules described herein completes the "string" of power conditioning modules with a broad selection of output voltages. Single output modules in two power ranges plus dual output modules for popular plus-minus voltages may be resistance trimmed or remotely programmed through external circuitry when required. All are equipped with zener diode overvoltage protection and the regulated modules will endure continuous short circuit conditions. All regulated outputs have a set point of $\pm 1\%$.

Higher load currents can be obtained with proper parallel connections discussed later in this literature. All output modules are interchangeable and will operate to full specification from any one of the high frequency generators over the full temperature range of -55°C to $+100^{\circ}\text{C}$. They are designed for convenient mounting to a heat conductive surface that will maintain the case within the operating temperature range.



TR,TRC,TD Transformer Isolated Output Modules

DESIGN INFORMATION

TABLE 1

Output Voltage	Maximum Continuous Load	Regulation in mV			Output Z DC to 10 kHz (~ typ.)	Case Size	Ripple*** mV p-p	Model Number
		Line Vin Min to Max	Load F.L. to N.L.	Line + Load				
Single Regulated Outputs								
5	3.0A	+ 25	+ 75	100	0.030	A	75	5TR30
	5.0A	+ 25	+ 75	100	0.025	B	75	5TR50
	6.5A	+ 25	+ 75	100	0.025	B	75	5TR65
6	2.5A	+ 25	+ 80	100	0.035	A	80	6TR25
	6.0A	+ 25	+ 80	100	0.035	B	80	6TR60
8	2.3A	+ 25	+ 80	100	0.040	A	90	8TR23
	4.0A	+ 25	+ 80	100	0.040	B	90	8TR40
10	2.0A	+ 30	+ 95	100	0.050	A	100	10TR20
	4.5A	+ 30	+ 95	100	0.050	B	100	10TR45
12	1.6A	+ 30	+ 105	120	0.055	A	110	12TR16
	4.0A	+ 30	+ 105	100	0.055	B	110	12TR40
15	1.3A	+ 30	+ 120	150	0.060	A	125	15TR13
	3.5A	+ 30	+ 120	120	0.060	B	125	15TR35
18	1.0A	+ 35	+ 130	165	0.070	A	140	18TR10*
	3.0A	+ 35	+ 130	140	0.070	B	140	18TR30
24	1.0A	+ 60	+ 135	180	0.100	A	170	24TR10*
	2.5A	+ 60	+ 135	180	0.100	B	170	24TR25
28	1.0A	+ 80	+ 135	200	0.120	A	190	28TR10*
	2.3A	+ 80	+ 135	200	0.120	B	190	28TR23
Dual Regulated Outputs								
5	1.0A ea.	+ 25	+ 75	100	0.10	A	75	5TRC10
6	1.0A ea.	+ 25	+ 80	105	0.10	A	80	6TRC10
10	1.0A ea.	+ 30	+ 95	125	0.10	A	100	10TRC10
12	1.0A ea.	+ 30	+ 105	135	0.10	A	110	12TRC10
14	1.0A ea.	+ 30	+ 115	145	0.15	A	120	14TRC10
15	1.0A ea.	+ 30	+ 120	150	0.15	A	125	15TRC10
18	0.9A ea.	+ 35	+ 130	165	0.15	A	140	18TRC9
24	0.5A ea.	+ 60	+ 135	195	0.15	A	170	24TRC5
Single Unregulated Outputs**								
Voltage Change (FL to ½ L)mV								
5	8.0A	NA	1000	NA		A	500	5TD80
12	3.0A	NA	1000	NA		A	150	12TD30
15	3.0A	NA	1000	NA		A	150	15TD30
18	2.5A	NA	1200	NA		A	150	18TD25
24	2.0A	NA	1200	NA		A	200	24TD20
28	1.5A	NA	1500	NA		A	350	28TD15

* Modules restricted to use with pre-regulated input sets. Otherwise use higher current (case size B) version.

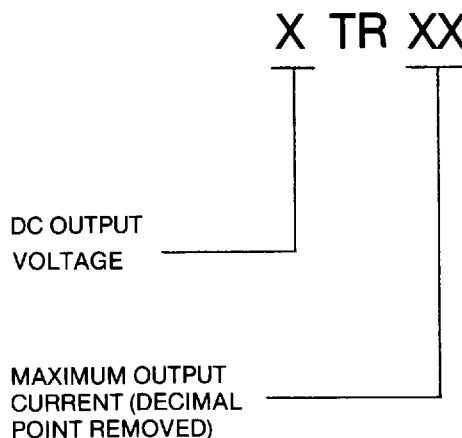
** Unregulated modules are used only with pre-regulated input sets.

*** 10 MHz Bandwidth

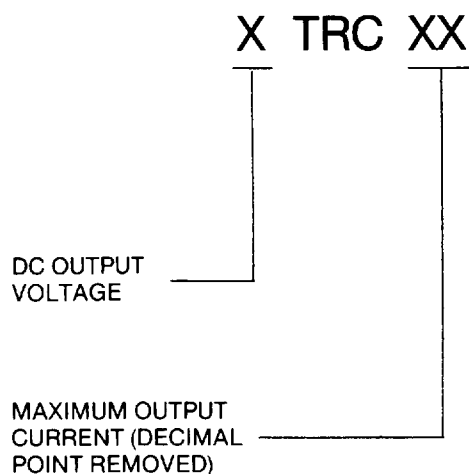
SPECIFICATIONS

Input Voltage:	40V min. peak square wave (from "Generator" module)
Ripple:	See Design Information and typical curves following. Data taken with feedthrough filters (see FTA specifications)
Operating Temperature:	-55°C to +100°C case (no derating)
Storage Temperature:	-65°C to +125°C
Temperature Coefficient:	0.025%/°C max.
Overcurrent Protection:	All TR and TRC modules can endure continuous short circuit conditions using foldback type current limit.
Overvoltage Protection:	Zener diode integral to all modules.
Weight:	Case size A — 3 oz. max. (85 gms) Case size B — 6 oz. max (170 gms)
Finish:	Anodize per MIL-A-8625-II, Class 2 over aluminum
Terminals:	0.040" diameter, solderable per MIL-T-10727

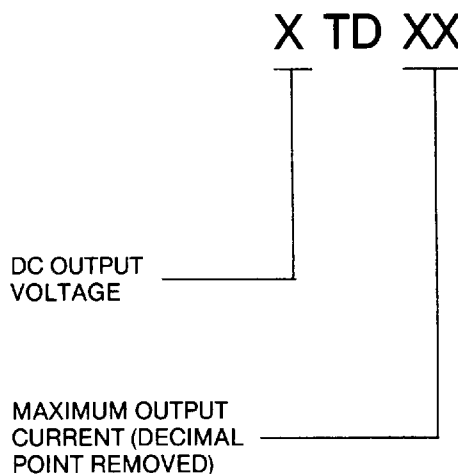
TR PART NUMBER DESIGNATION



TRC PART NUMBER DESIGNATION

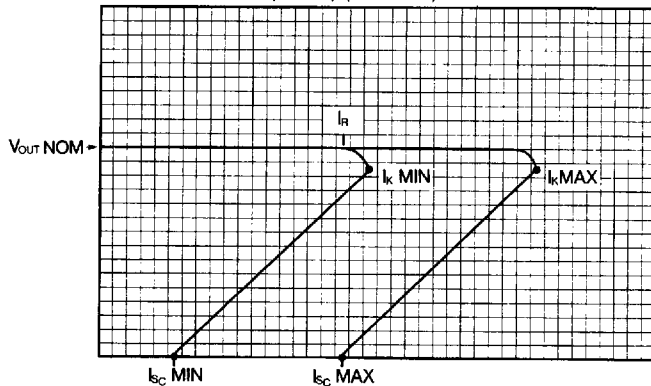


TD PART NUMBER DESIGNATION



TR,TRC,TD Transformer Isolated Output Modules

CURRENT LIMITING (+25°C) (TYPICAL)

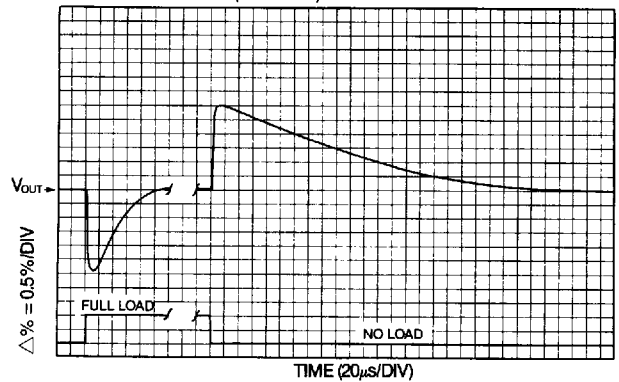


I_R = RATED OUTPUT CURRENT
 I_K = KNEE CURRENT—that point beyond I_R where V_{OUT} drops to 10% Below V_{NOM} .
 At +25°C = I_K is 1.1 to 1.8 x I_R
 At -55°C = I_K is 1.2 to 1.9 x I_R
 At +100°C = I_K is 1.0 to 1.5 x I_R

I_{SC} = SHORT CIRCUIT CURRENT—that level to which "FOLDBACK CURRENT LIMITING" will go to during short circuit loading.
 $I_{SC} = 0.1$ to $1.3 I_R$ from -55°C to +100°C.

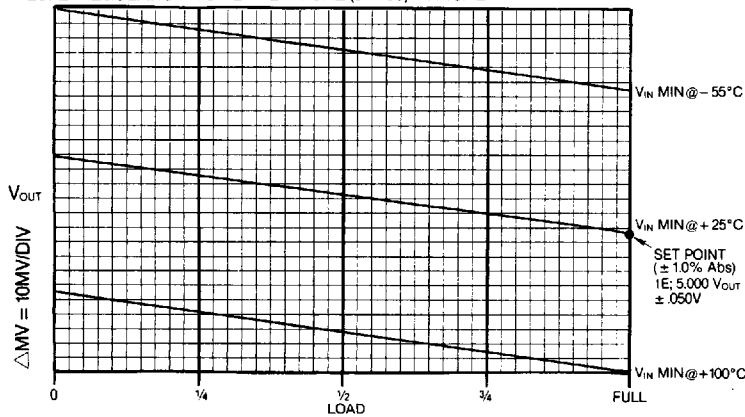
NOTE: 1) Higher voltage (15V & above) TR and TRC modules have higher I_{SC} to I_K ratios than low voltage (14V & below) units.
 2) Latching may occur if constant current load is used.

TRANSIENT RESPONSE (TYPICAL)



Multiply $\Delta\%$ by V_{OUT} of TR or TRC to get ΔV peak.

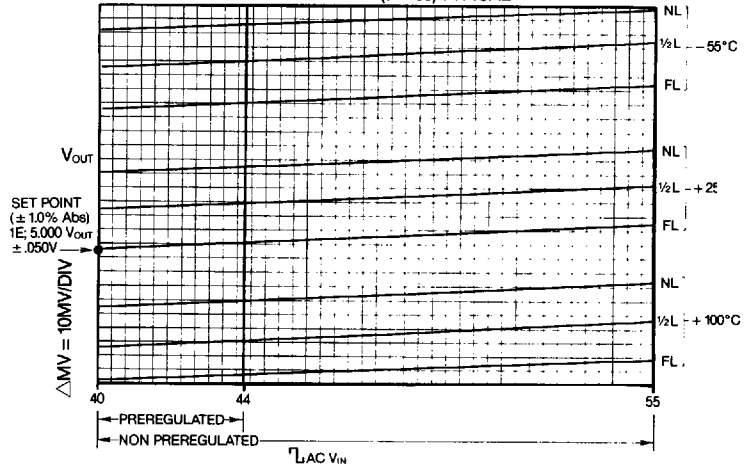
LOAD REGULATION VS TEMPERATURE (5TR65) TYPICAL



NOTE: Data taken at module pins.

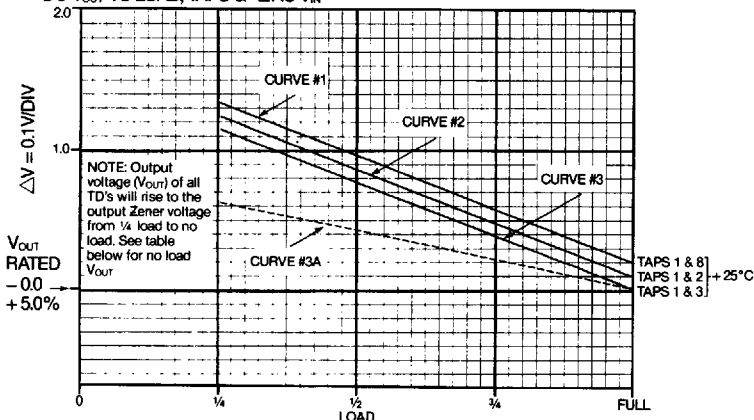
MULTIPLIERS FOR ALL OTHER TR's & TRC's									
V_{OUT}	5	6	8	10	12	15	18	24	28
ΔMV BY	1.0	1.1	1.1	1.2	1.3	1.5	1.6	1.7	1.8

LINE REGULATION VS TEMPERATURE (5TR65) TYPICAL



MULTIPLIERS FOR ALL OTHER TR's & TRC's									
V_{OUT}	5	6	8	10	12	15	18	24	28
ΔMV BY	1.0	1.0	1.0	1.1	1.1	1.1	1.2	2.2	2.7

DC V_{OUT} VS LOAD, TAPS & $\Gamma_{LAC} V_{IN}$

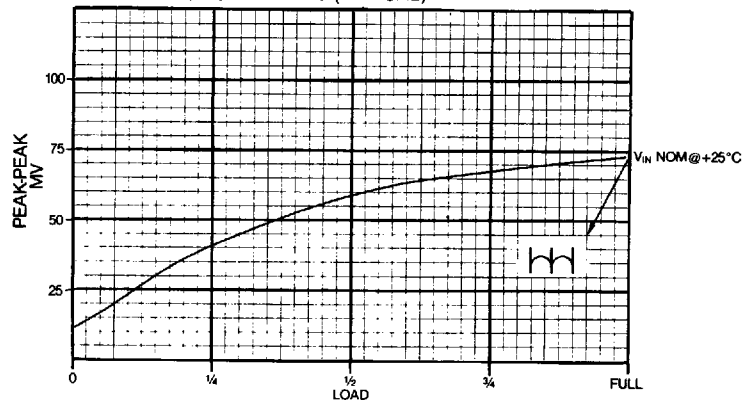


For all TD's except 5TD add ΔV_{OUT} from curve #1, 2 or 3 to V_{OUT} Rated. For 5TD use curve #3A only.

CURVE #1 = 40 Vp AC VIN
 CURVE #2 = 42 Vp AC VIN
 CURVE #3 = 44 Vp AC VIN
 CURVE #3A = 40 Vp AC VIN

NO LOAD V_{OUT}									
V_{OUT}	5	12	15	18	24	28			
VZENER	9	26	28	36	36	53			

RIPPLE/NOISE VS LOAD 15TR13 (TYPICAL)*



* DATA SHOWN USING CF 1005
 FEED THRU MEASURED AT
 FEED THRU OUTPUT
 (10 MHz BANDWIDTH)

MULTIPLIERS FOR ALL OTHER TR's & TRC's									
V_{OUT}	5	6	8	10	12	15	18	24	28
MV P-P BY	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.2	1.3

TABLE 2

VDC OUTPUT	Efficiency for Output Modules						(Typical @ Vin Min)
	TR & TRC			TR			TD
	CASE A (1"x2"x1")			CASE B (2"x2"x1")			CASE A (1"x2"x1")
	A*	B*	C*	A*	B*	C*	All Conditions
5.0	56%	50%	46%	59%	53%	49%	78%
6.0	60%	54%	50%	63%	57%	53%	81%
8.0	63%	60%	55%	68%	62%	58%	—
10.0	71%	65%	60%	74%	67%	62%	87%
12.0	75%	68%	62%	77%	70%	64%	89%
14.0	77%	71%	65%	—	—	—	—
15.0	78%	72%	66%	81%	74%	68%	91%
24.0	86%	79%	72%	87%	80%	73%	94%
28.0	87%	80%	73%	89%	82%	75%	95%
50.0	89%	81%	74%	—	—	—	—
80.0	93%	80%	77%	—	—	—	—

Condition A* output and generator modules operating in excess of two-thirds of rated load. Refer to module rating in catalogue.

Condition B* output module operating one-third to two-thirds of rated load supplied by a generator module operating in

excess of two-thirds rated load OR generator operating at one-third to two-thirds of rated load and output modules operating in excess of two-thirds rated load.

Condition C* output and generator modules operating at one-third to two-thirds of rated load.

APPLICATIONS INFORMATION

To insure optimum performance of the Transformer Isolated Output Modules, the following applications information is offered.

Filtering

The TR and TRC modules provide linear regulation and therefore reduced ripple and noise. However, we do recommend the use of feedthrough filters described elsewhere in our literature. These filters, or their equivalent, will provide effective high frequency filtering of switching noise. Applications data and ripple specifications are detailed in Powercube feedthrough filter data sheet. When the more stringent sections of MIL-STD-461 EMI requirements must be dealt with, our technical personnel may recommend the use of additional filtering tailored to your specific configuration and line/load characteristics. In the majority of cases, however, the feedthrough filters are sufficient.

Parallel Operation

The 5TR50 is the only regulated output module designed for either single or parallel operation without modification or special provisions. When its output is paralleled with the output of another 5TR50 it will provide up to 10A without degradation of output characteristics or derating. Other regulated output modules (case size B) are available for parallel operation, however, they must be specified with the suffix "M" or "S" (for master and slave) when their intended use is in pairs for parallel operation. For example, if 8V at 8A is desired (regulated) an 8TR40M and an 8TR40S will provide

this in parallel. (These need not be ordered as "matched pairs") If three or more modules are to be used with their outputs in parallel, a technical representative of Powercube should evaluate the specific intended application and advise what, if any, precautionary measures must be employed to assure full reliable performance.

Multiple Strings For More Power

Using the efficiency values shown in Table 2, the designer will determine the maximum number of output modules which a single Generator module can drive. If all loads do not simultaneously run at maximum, the designer is free to take advantage of this. However, it is common to increase the total power capability of the power supply system by merely adding additional input modules as required. Their small size and light weight will provide the desired high density of power without affecting the total flexibility afforded the designer. When adding additional input modules, it is advisable to re-distribute the output modules as necessary to balance the loads on the generators for thermal considerations.

Regulated vs. Unregulated

The TD modules contain no regulating elements, however, if small load changes are anticipated, the output voltage change may be acceptable (see Table 1). A minimum loading of 25% is required on all TD modules. The designer is encouraged to consider the performance and higher efficiency offered by these modules when making his choice between TD's or TR's.

TR,TRC,TD Transformer Isolated Output Modules

APPLICATIONS INFORMATION (cont'd)

Overcurrent and Overvoltage Protection

All TR and TRC output modules are current "foldback" protected and will sustain continuous short-circuit conditions without damage.* A short circuit condition on one module will not affect the performance of other output modules. The output characteristics are automatically recovered upon removal of the fault condition (see curves for more detail).

All output modules protect the load from damage to over-voltage conditions which exceed the threshold of the zener diode, placed internally across the output.

If an external overvoltage condition is of sufficient energy, the zener will fail shorted protecting the load.

For those applications where "crowbar" protection is preferable, Powercube offers such protection in a variety of voltages and current ratings which are designed for mechanical as well as electrical compatibility with a Cirkitblock system.

Trimming and Remote Programming

TR's and TRC's: TR's and, upon request, TRC's, are provided with a trim terminal. To compensate for line drops or for some specialized applications, we have provided a means for the user to trim the output voltage of an encapsulated module. A separate applications bulletin describes this method of resistance programming in detail. This same

feature also allows remote programming which is described as well. Remote programming of a negative output will require an isolated control source. Trimming output voltages due to drift will not be necessary with Cirkitblock modules.

TD's: The TD output modules provide 3 "tap" connections (except for 5V modules) which allow the user a method of obtaining slightly higher or lower output voltages by simply selecting the proper pair of input terminals (see curve). This is covered in greater detail in our separately published applications bulletin.

Other Output Voltages

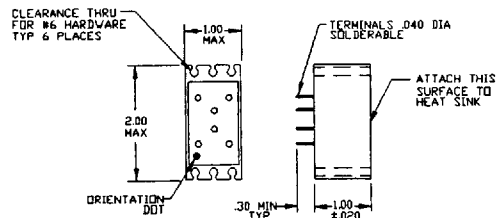
The preceding data lists output voltages most often encountered in power supply design. They are our "standards" and as such are available from stock. Powercube can easily provide higher voltages or "in-between" voltages when required either by special design or by trimming prior to encapsulation. These "special" modules are compatible with our standard modules and will operate in the same "strings."

Interconnect and Mounting

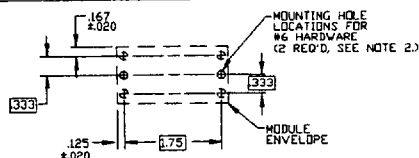
As with all Cirkitblock modules, the output modules are normally interconnected by hard wiring but, with some restrictions, lend themselves to printed circuit or "flex" interconnect methods. All modules are designed to be firmly mounted to a heat conducting surface. Use of thermal compound is recommended.

*Please note TD modules are not foldback protected

CASE A DIMENSIONAL DRAWINGS



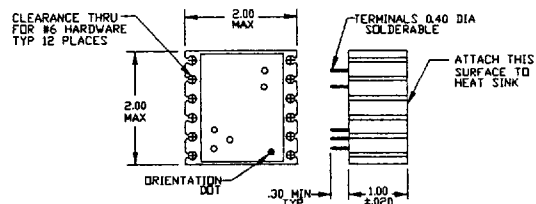
MOUNTING DIMENSIONS



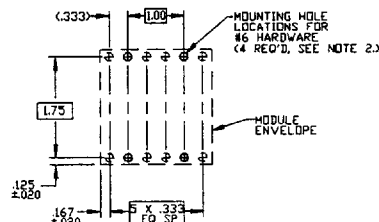
NOTES:

1. ALL DIMENSIONS IN INCHES.
2. A TOTAL OF 2 MOUNTING SCREWS ARE RECOMMENDED, 1 ON EACH SIDE OF THE MODULE. POWERCUBE SUGGESTS THAT THE "CENTER" LOCATIONS (SHOWN AS SOLID CIRCLES) BE USED.

CASE B DIMENSIONAL DRAWINGS



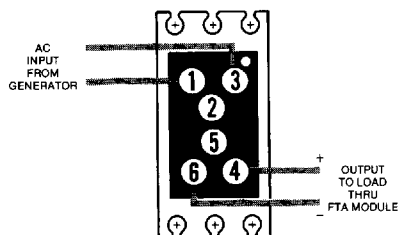
MOUNTING DIMENSIONS



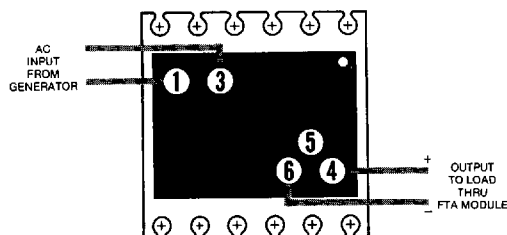
NOTES:

1. ALL DIMENSIONS IN INCHES.
2. A TOTAL OF 4 MOUNTING SCREWS ARE RECOMMENDED, 2 ON EACH SIDE OF THE MODULE. POWERCUBE SUGGESTS THAT THE 2 SPACED AT 1.00 INCH (SHOWN AS SOLID CIRCLES) BE USED.

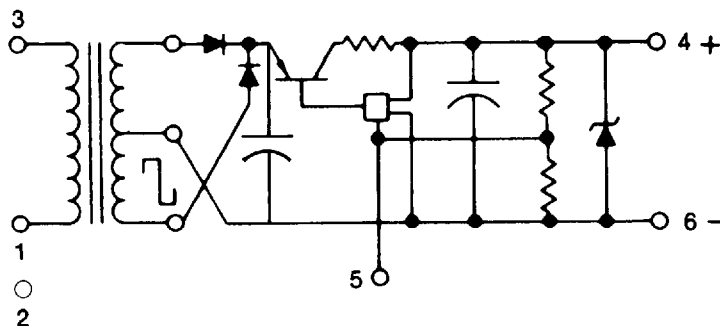
FUNCTIONAL DRAWING



FUNCTIONAL DRAWING



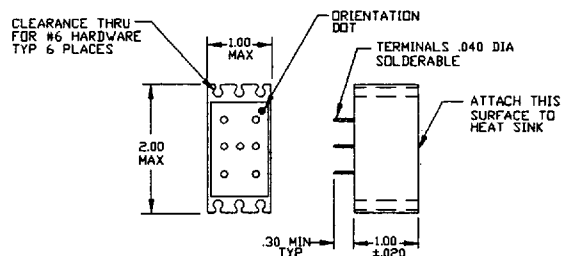
ELECTRICAL SCHEMATIC



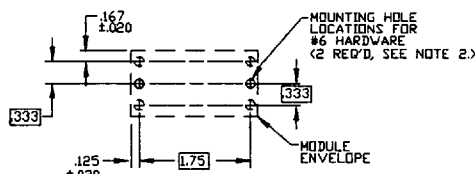
TR,TRC,TD Transformer Isolated Output Modules

TRC DIMENSIONAL DRAWINGS

MODULE DIMENSIONS



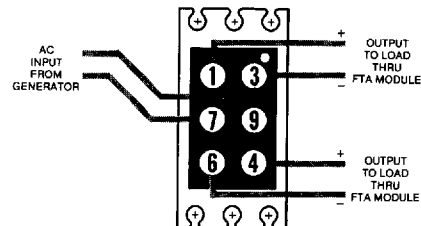
MOUNTING DIMENSIONS



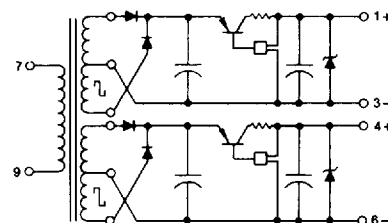
NOTES:

1. ALL DIMENSIONS IN INCHES.
2. A TOTAL OF 2 MOUNTING SCREWS ARE RECOMMENDED, 1 ON EACH SIDE OF THE MODULE. POWERCUBE SUGGESTS THAT THE "CENTER" LOCATIONS (SHOWN AS SOLID CIRCLES) BE USED.

FUNCTIONAL DRAWING

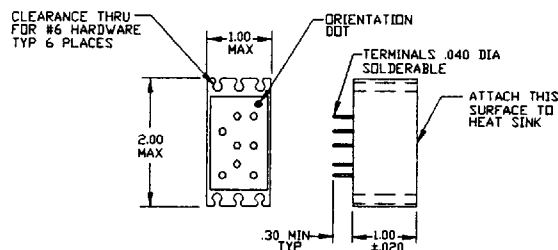


ELECTRICAL SCHEMATIC

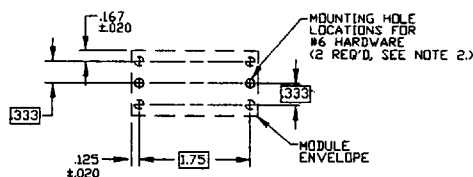


TD DIMENSIONAL DRAWINGS

MODULE DIMENSIONS



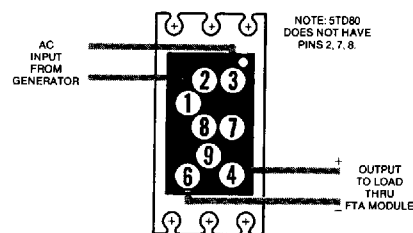
MOUNTING DIMENSIONS



NOTES:

1. ALL DIMENSIONS IN INCHES.
2. A TOTAL OF 2 MOUNTING SCREWS ARE RECOMMENDED, 1 ON EACH SIDE OF THE MODULE. POWERCUBE SUGGESTS THAT THE "CENTER" LOCATIONS (SHOWN AS SOLID CIRCLES) BE USED.

FUNCTIONAL DRAWING



ELECTRICAL SCHEMATIC

