SILICON POWER
275 Great Valley Parkway
Malvern, PA 19355
Ph: 610-407-4700

CCSTA43N40A10

Solidtron™

N-Type Semiconductor Discharge Switch, ThinPak™

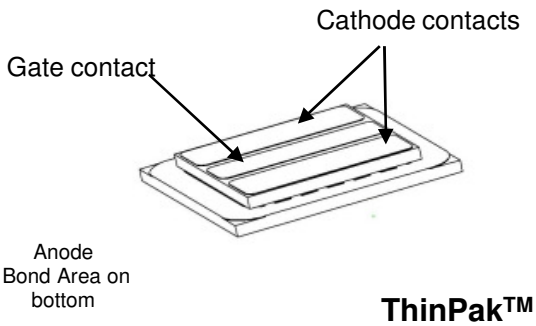
Description

This current controlled Solidtron™ (CCS) discharge switch is an n-type Thyristor in a high performance ThinPak™ package. The device gate is similar to that found on a traditional GTO Thyristor.

The CCS features the high peak current capability and low On-state voltage drop common to SCR thyristors combined with high di/dt capability. This semiconductor is intended to be a solid state replcement for spark or gas type devices commonly used in pulse power applications.

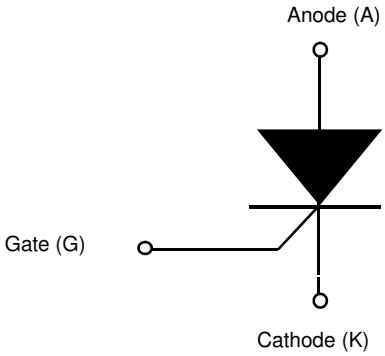
The ThinPak™ Package is a perforated, metalized ceramic substrate attached to the silicon using 302ºC solder. It's small size and low profile make it extremely attractive for high di/dt applications where stray series inductance must be kept to a minimum.

Package Size - 9



ThinPak™

Schematic Symbol



Features

- 4000V Peak Off-State Voltage
- 5 kA Repetitive Ipk Capability
- 25 KA/uS di/dt Capability
- Low On-State Voltage
- Low trigger current
- Low Inductance Package

Absolute Maximum Ratings

	SYMBOL	VALUE	UNITS
Peak Off-State Voltage	V_{DRM}	4	kV
Peak Reverse Voltage	V_{RRM}	-5	V
Off-State Rate of Change of Voltage Immunity*	dv/dt	1	kV/uSec
Continuous Anode Current at Tj = 125 °C	I_{A110}	50	A
Repetitive Peak Anode Current (Pulse Width=10uSec)	I_{ASM}	5.0	kA
Nonrepetitive Peak Anode Current (Pulse Width=10uSec)	I_{ASM}	8	kA
Rate of Change of Current	dI/dt	25	kA/uSec
Peak Gate Current (1 uS)	IGpk	50	A
Max. Reverse Gate-Cathode Voltage	V_{GR}	-9	V
Maximum Junction Temperature	T_{JM}	125	°C
Maximum Soldering Temperature (Installation)		260	°C

This **SILICON POWER** product is protected by one or more of the following U.S. Patents:

5,521,436	5,446,316	5,105,536	5,209,390	4,958,211	5,206,186	4,857,983	5,082,795	4,644,637
5,585,310	5,557,656	5,777,346	5,139,972	5,111,268	5,757,036	4,888,627	4,980,741	4,374,389
5,248,901	5,564,226	5,446,316	5,103,290	5,260,590	5,777,346	4,912,541	4,941,026	4,750,666
5,366,932	5,517,058	5,577,656	5,028,987	5,350,935	5,995,349	5,424,563	4,927,772	4,429,011
5,497,013	4,814,283	5,473,193	5,304,847	5,640,300	4,801,985	5,399,892	4,739,387	5,293,070
5,532,635	5,135,890	5,166,773	5,569,957	5,184,206	4,476,671	5,468,668	4,648,174	

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Performance Characteristics T_J=25°C unless otherwise specified

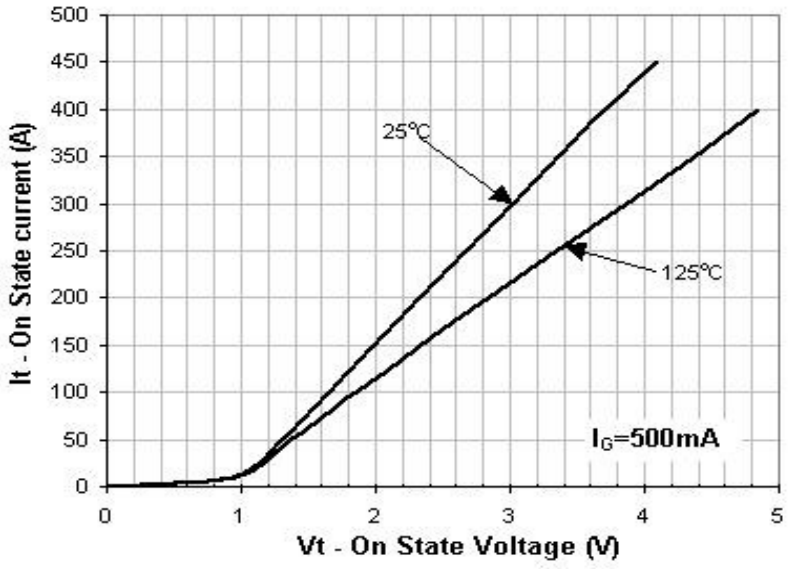
Parameters	Symbol	Test Conditions		Measurements Min.	Typ.	Max.	Units
Anode to Cathode Breakdown Voltage	V_{DR}	V_{GK}=0, I_A=1mA Note: 3		4			kV
Anode-Cathode Off-State Current	I_D	V_{GK}=0V, V_{AK}=4000V	T_J=25°C		20	100	uA
		Note: 3 & 4	T_J=125°C		100	800	uA
Turn-On Threshold Current	$V_{GK(TH)}$	V_{AK}=V_{GK}, I_{AK}=1mA , see Note: 3 & 5			70		mA
Gate-Cathode Leakage Current	$I_{GK(lkg)}$	V_{GK}=-9V, see Note: 1				-20	uA
Anode-Cathode On-State Voltage	V_T	I_T=100A	T_J=25°C		1.8		V
		Ig = 500 mA	T_J=125°C		2		V
Turn-on Delay Time	$t_{D(ON)}$	C=0.75 uF Capacitor discharge			160		ns
Pk Rate of Change of Current (measured)	dI/dt	Ls=150nH			25		kA/us
Peak Anode Current	I_P	R_{gk} = 10 ohms	V_{AK} = 3750 V		2950		A
		Gate di/dt =100 A/us	T_c=25°C				

Notes:

1. Measurements made with a 10 Ohm shorting resistor connected between the gate and cathode.
2. Case Exterior Assummed to be 0.002" of 63Sn/37Pb solder applied directly to cathode bond area of ThinPak.
3. Performance guarenteed by design only.
4. Production testing is limited to 2KV prior to encapsulation.
5. Characterization accomplished using R_{gk}=10 ohms.

Typical Performance Curves (unless otherwise specified)

Figure 1.
Measured Low current On-State Characteristics.



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Typical Performance Curves (Continued)

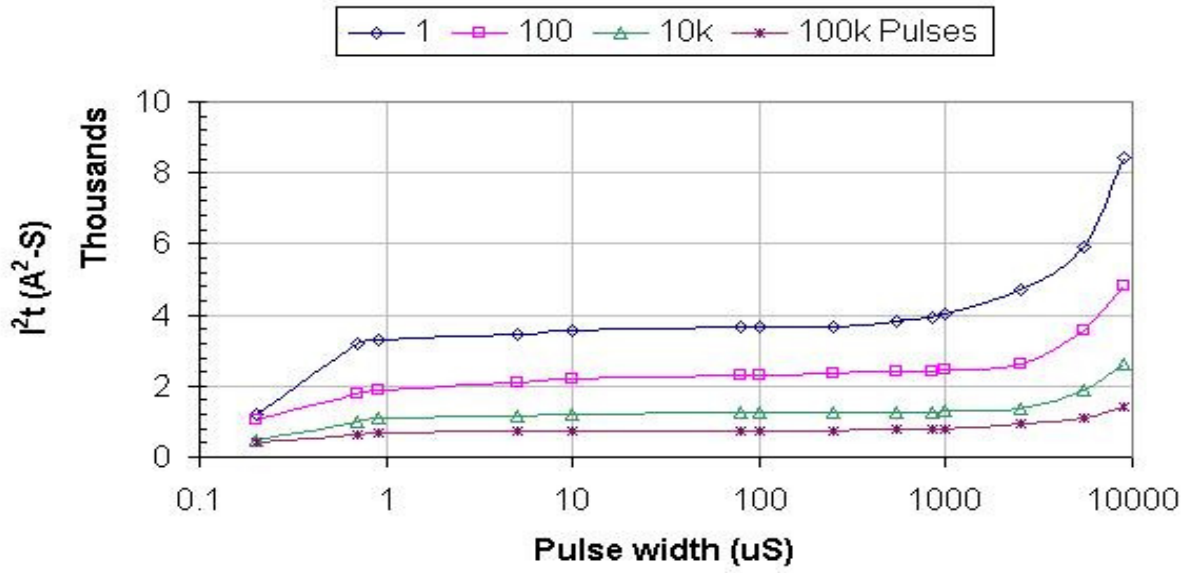
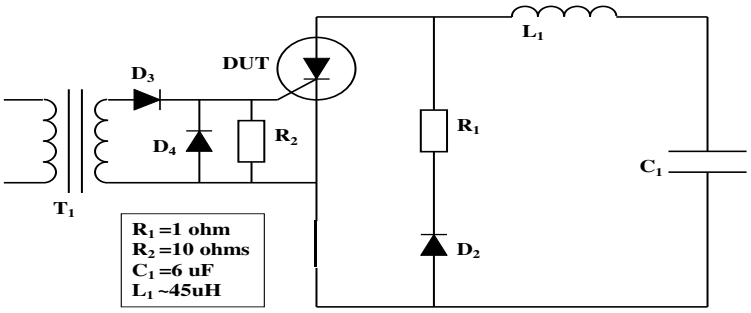
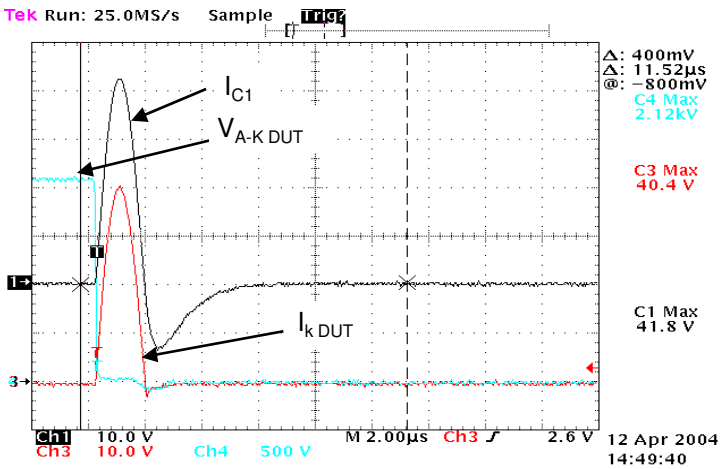


Figure 3. Predicted I^2t data for various number of discharge cycles. Pulses are assumed rectangular. The device junction temperature T_J is assumed to be at 25°C before each discharge event.

Test Circuit



- $L_{SERIES(TOTAL)}$ can be caculated using equation 1 / (f 2π)^{2}C where f = frequency of I_K when using CCSTA43N40 for circuit set up and calibration.



- The waveform shown is representative of one produced using the test circuit shown where the DUT is the CCSTA43N40 Solidtron. The C1 capacitor voltage in this example was at 3750V. Ik peaked at 4kA at 1us and the peak gate current Ig is 1A.

Figure 4. Typical test circuit and waveforms.

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Application Notes

A1. Pulse Transformer Gating

A preferred method of isolation, a pulse transformer may be used to predictably and reliably trigger the Thyristor. This gating method allows the user to easily connect the devices in parallel or series (See Fig. A1.2 for series example).

Components *(Fig. A1.1)*

T_1 - Method of electrically isolating the device from control circuitry. Pulse X-former insulation characteristic must be selected based on application requirements.

R_1 (or **R_{GK}**) - Serves as a keep-off resistor, shunting dv/dt induced, capacitively coupled Anode-Gate current to the Cathode. The lower the value of R_1, the better the dv/dt immunity of the sub-circuit. In the event R_1 must be increased to the point where it's resistance compromises the dv/dt requirement of the application, a low voltage capacitor (.1-.2uF) may be placed in parallel to provide a more responsive shunt path; however, the added capacitance will require more charge be delivered to satisfy the turn-on requirements outlined in the simplified theory of operation.

D_1 & D_2 - Current steering diodes. Reverse gate current increases the impedance of the device ("attempted turn-off"). Reverse gate current experienced during a high current discharge event may permanently damage the device. D_1 restricts the direction of current flow through the secondary while D_2 provides a "free-wheeling" or holding path to the gate.

It is highly recommended that the components listed above, specifically R_1 and D_2 be placed in as close physical/electrical proximity to the device as the application will allow. Parasitic inductance in series with the Gate to Cathode shunt path will also compromise the dv/dt immunity of the device.

Theory of Operation *(Refer to Fig. A1.1)*

A current pulse supplied to the primary of T_1 induces a current into the secondary of T_1. Current supplied by the T_1 secondary forward biases D_1 supplying current through R_1; thus, developing voltage across R_1 until the gate of the Thyristor is forward biased (~0.7V). Current is then supplied to the Gate of the Thyristor until turn-on (latched-on) is achieved. Following the discharge event, once the Thyristor current reaches zero and it's stored charge is cleared (Storage Time) the circuit is reset and Anode voltage may be reapplied.

Example: Turn-on will occur with R_1=5 ohms, $I_{T1\text{-}S}$ =/> 140mA

It is recommended that T_1 secondary current ($I_{T1\text{-}S}$) =/> 0.7V / R_1 be supplied for approximately 2uSec. Device turn-on delay ($T_{D\text{-}ON}$) is typically less than 200nSec.

Although $I_{T1\text{-}S}$ = 0.7V / R_1 is sufficient to turn the device on, we typically recommend, where possible, $I_{T1\text{-}S}$ =/ >500mA, Pulse Duration =/> 5uSec with R_1= 10 ohms.

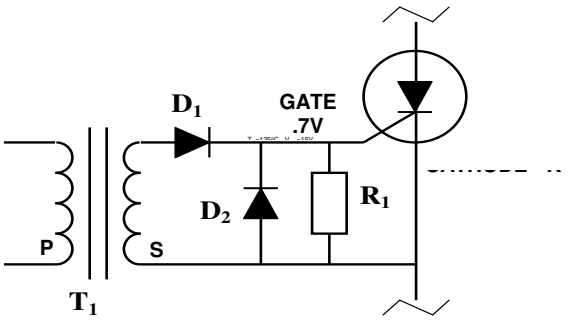

Figure A1.1
Basic Pulse X-Former
Gating Circuit

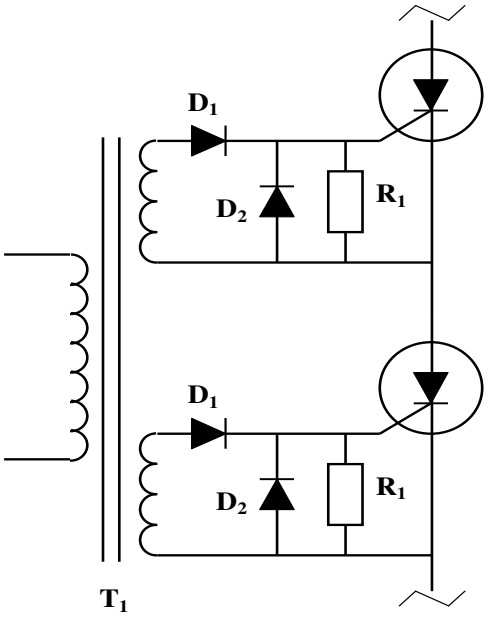

Figure A1.2
Series Connection
Pulse X-Former Gating

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Packaging and Handling

1. ATTENTION OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES IN ALL ASSEMBLY AND TEST AREAS. Proper handling procedures must be observed to prevent electrostatic discharge which may result in permanent damage to the device.

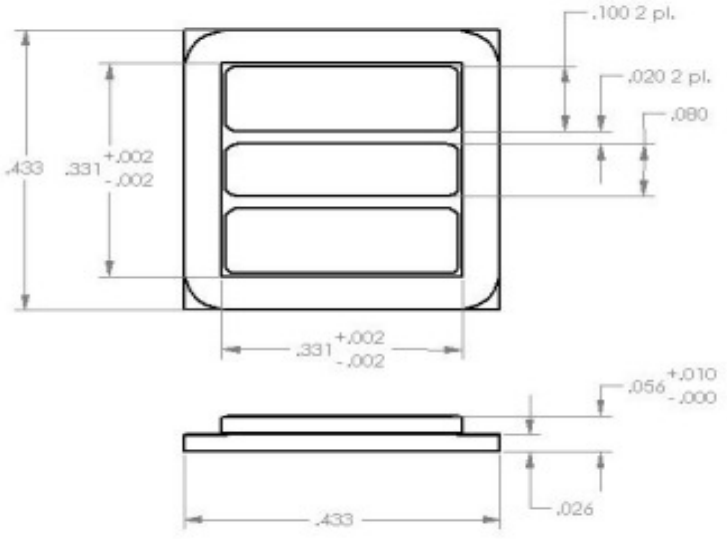
2. The CCSTA43N40 uses an undersized ceramic "lid" which exposes the sensitive Junction Termination Extention (JTE) of the device. The user is required to encapsulate the device in an encapsulant prior to applying high voltage. This prevents debris and contaminants from compromising the JTE.

2. Use of a seperate gate return path instead of the cathode power contact is recomended to minimize the effects of rapidly changing Anode-Cathode currents.

3. Shorting resistor R_{GK} is application specific. It can control the gate drive requirements and some device properties. However, R_{GK} = 10 Ohms satisfies most application requirements.

4. Installation reflow temperature should not exceed 260°C or internal package degradation may result.

Dimensions



Revision History

Rev	Date	EA #	Nature of Change
0	**10-24-2007**	04242009-NB-0016	Initial Issue