CURRENT SHARE CIRCUIT MODULE
CSC01
APPLICATION NOTE

Approved By:

Department	Approved By	Checked By	Written By
Research and Development Department	Ovid	Wei-Cheng	SYLin
Design Quality Department	Benny	JoJo	

Contents

CSC01
Application Note V11

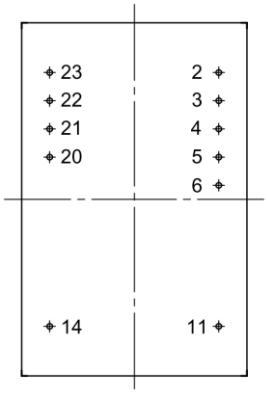
1. Introduction

"Current sharing" is a technique used in converters, which enables system load current evenly across all converters when in-parallel operation. It is also known as load sharing. The main benefit of "Current sharing" is to let the system run cooler and improve reliability by equally distributing the load among all converters. Especially in high-power systems, the benefits of this technology are more pronounced, increasing system stability and reducing system costs.

The CSC01 (Current Sharing Circuit 01) utilizes the "Voltage Droop" method to achieve "Current Sharing". It creates the voltage variance at the negative output when putting on the load, which allows two or more converters to balance the current. One application case for CSC01 is to utilize in PDF700S/PDF700S-CMFD parallel.

As the market demands higher power for electrical equipment. To achieve a high-power system by using converters in parallel, it may be necessary to use multiple converters in parallel. However, this requires current sharing techniques to ensure that the load current can be shared equally. CINCON offers parallel solutions for different requirements. If you have any questions about paralleling and current sharing, please contact CINCON for more information.

2. Pin Function Description

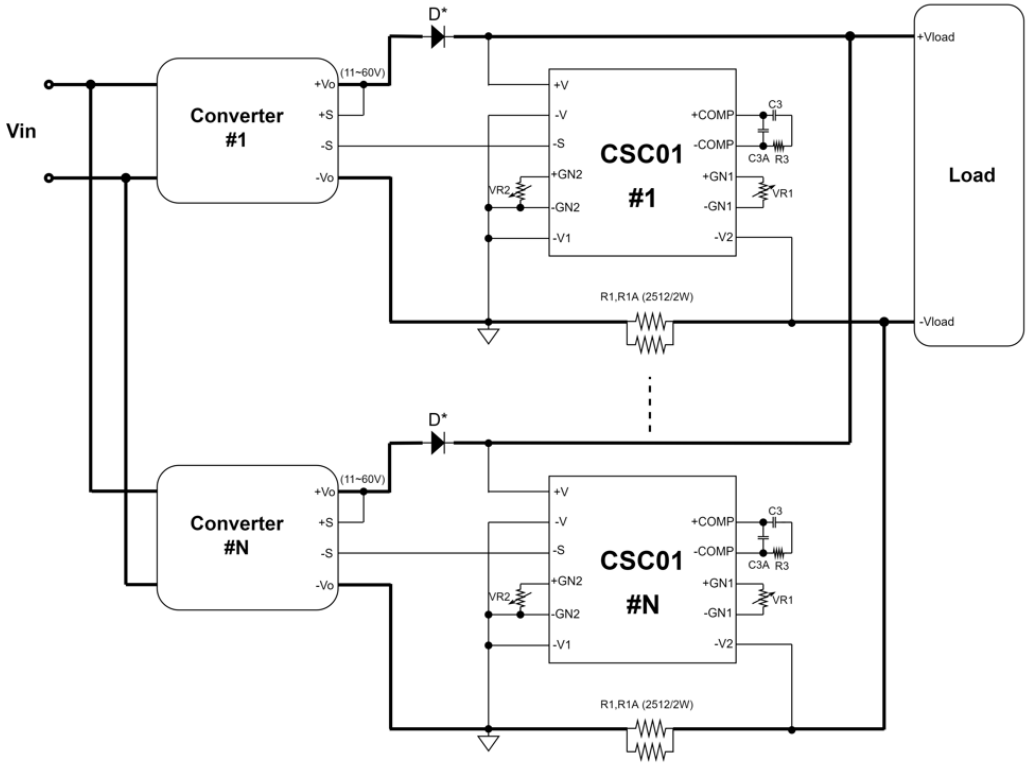


BOTTOM VIEW

No	Label	Function	Description
2	-V1	-V1 Signal	Sense Resistor for Converter Side
3	-GN1	Voltage Adjustment	Adjust Full Load Output Voltage with VR1
4	-GN2	Voltage Adjustment	Adjust Null Load Output Voltage with VR2
5	-COMP	Feedback	Negative Feedback Compensation
6	-S	-Sense	Negative Output Remote Sense of Converter
11	-V	Ground	Ground
14	+V	Provide Bias	Power Supply Providing Bias to CSC01
20	+COMP	Feedback	Positive Feedback Compensation
21	+GN2	Voltage Adjustment	Adjust Null Load Output Voltage with VR2
22	+GN1	Voltage Adjustment	Adjust Full Load Output Voltage with VR1
23	-V2	-V2 Signal	Sense Resistor for Load Side

3. Connection for Standard Use

The connection for standard use is shown below. The external D is ORing Diodes. It is recommended for the protection of the parallel system. The external R1/R1A is sense resistor. The external VR1 is adjustable resistor. It is used to adjust the output voltage at full load and can be replaced by a normal resistor after confirming the resistance value. The external VR2 is adjustable resistor. It is used to adjust the output voltage at null load and can be replaced by a normal resistor after confirming the resistance value. The external R3/C3/C3A is resistor and capacitor for feedback compensation. The typical value of R3 and C3 is null and C3A is 0.22uF. (The capacitance values may vary depending on the converter.)



Symbol	Component
D*	External ORing diodes. Refer to Chapter 4
VR1	External adjustable resistor. It is used to adjust the output voltage at full load. Refer to Chapter 5
VR2	External adjustable resistor. It is used to adjust the output voltage at null load. Refer to Chapter 5
R1, R1A	External sense resistor. Refer to Chapter 5
R3, C3, C3A	External resistor and capacitor for feedback compensation. The typical value of R3 and C3 is null and C3A is 0.22uF
+Sense, -Sense	External voltage compensation for converter

4. Prerequisites

1. The CSC01 (Current Sharing Circuit 01) uses “Voltage Droop” to allow two or more converters to share current for parallel operation. Therefore, the output voltage trim up/down function of the converter is required (trim +3% and -2%).

2. It is recommended that the number of converters connected in parallel to the CSC01 should not exceed eight units. However, the maximum number of converters to be paralleled is different for each type of converter due to its own electrical characteristics, so the maximum number of converters to be paralleled must be determined by the actual results of paralleling. When connecting converters in parallel, it is also necessary to ensure that the overall electrical characteristics of the parallel system, such as EMI, leakage current, inrush current, etc., meet the standards or requirements.

3. The remote sense function (+S/-S) of the converter is required. When the converter is connected in parallel with the CSC01, make sure that the -S and -V pin of CSC01 are open to avoid damage.

4. The remote on/off function of the converter is required. The remote on/off of each converter should be connected together so that the remote on/off signal is sent to each parallel converter at the same time. This ensures that the parallel converters can start up at the same time during remote control.

5. The output voltage accuracy adjustment function of the converter is required, it is recommended that the output voltage error of each converter to be adjusted to less than 0.3% before paralleling, the smaller the accuracy, the better.

6. When operating in parallel, it is necessary to avoid over current protection (OCP) triggering during start-up, and the following should be noted:

(a) To avoid OCP, the total load current should be less than the rated current of one converter before all the parallel converters have completed startup.

(b) Set the output voltages of each converter to the same voltage. It is recommended that the voltage difference between each unit be less than 0.3%.

(c) The output conductors/cables must be of the same length and wire gauge to avoid various voltage drops.

(d) The maximum total power after parallel operation is recommended to be 85% of the total rated power.

7. -V1 and -V2 of the CSC01 should be connected directly to the two ends of the sense resistor (R1/R1A), the closer to the sense resistor the better.

8. The ORing diodes (D*) allow current to flow in one direction, isolating the fault units and allowing the system to continue operating with the remaining converters. The ORing diode (D*) is recommended in the parallel system. It is recommended that the repetitive peak reverse voltage (V_{RRM}) of the ORing diode be more than 1.2 times the rated voltage of the converter, and the average forward current ($I_{F(AV)}$) be 2 times the rated current of the converter. The forward voltage drop (V_F) of the diode, the lower the better, dissipates power and generates heat, so better thermal management is needed.

   V_{RRM} : V_{RRM} is called repetitive peak reverse voltage or repetitive peak reverse bias. Applying a negative voltage to the anode side relative to the cathode is reverse bias, and the applied voltage is reverse bias.

   $I_{F(AV)}$: $I_{F(AV)}$ is called average forward current. The current that flows through a diode when forward voltage is applied is called forward current.

   V_F : V_F is call forward voltage drop or forward bias. A positive voltage is applied to the anode side of the diode and a negative voltage is applied to the cathode side, which is called forward bias, and the applied voltage is forward bias.

9. CSC01 is suitable for converters with 11~60V_{dc} output. In other words, the voltage range from +V to -V is limited to 11~60V_{dc}.

10. It is not recommended to use CSC01 to parallel a converter with constant current (CC) function because the constant current function may interfere with the parallel signal.

11. CSC01 is suitable for PDF700S/PDF700S-CMFD parallel operation. For typical circuit applications, refer to the block diagram above **[Connection for Standard Use]** and the following parameters:

Converter	VR1	VR2	R1	R1A	C3A
PDF700S120-CMFD	200KΩ	2.05KΩ	2mΩ/2W/2512	2mΩ/2W/2512	0.01uF
PDF700S240-CMFD	270KΩ	6KΩ	5mΩ/2W/2512	5mΩ/2W/2512	0.01uF
PDF700S280-CMFD	230KΩ	4.02KΩ	5mΩ/2W/2512	5mΩ/2W/2512	0.22uF
PDF700S480-CMFD	422KΩ	13.5KΩ	10mΩ/2W/2512	10mΩ/2W/2512	0.22uF
PDF700S560-CMFD	470KΩ	17.6KΩ	10mΩ/2W/2512	10mΩ/2W/2512	0.22uF

5. How to Design Parallel Operation

How to use CSC01 to design a parallel system with 12V output for a total power requirement of 1000W? Follow the steps below:

Step 1. **Select the correct converters:**

Parallel system is recommended to use less than 85% of the total power, which means total power has to be greater than 1176W (1000W /0.85=1176.47W). When paralleling, all converters have to be the same model.

Step 2. **Select the CSC01 sense resistor (R1/R1A):**

When used at 85%-load, the voltage of the sense resistor in CSC01 is 50mV as a reference for selecting a suitable resistance value. The calculation formula for sense resistance is as follows, please note that the power stress of R1/R1A cannot exceed the limit value.

$$R_{sense} = \frac{50mV}{85\% \, current}$$

Where:

R_{sense} is the sense resistor, R_{sense} =R1//R1A (parallel)

85% current means 85% of the rated current (single converter)

Step 3. **Precise output voltage of converters:**

At no load, adjust the output voltage to 0.98 times the rated voltage, and then the error should not exceed 0.3%. This is to allow the current share to perform well.

Step 4. **Connecting a CSC01 to the converter:**

Connect the CSC01 to the output side of the converter, and the connection method can be referred to the above **[Connection for Standard Use]** , note that only one CSC01 and one converter are needed. Do not install the ORing diode (D*) at this time.

Step 5. Determine VR2:

After the CSC01 is connected to the converter, it can be adjusted to 1.03 times the rated voltage using the VR2 resistor and determine the resistance value of VR2 accordingly.

Step 6. Determine VR1:

After determining VR2, adjust the 100% load output voltage to 0.98 times the rated voltage using the VR1 resistor, and determine the resistance value of VR1 accordingly. When adjusting the parameters of the second converter, repeat steps 1 to 7. Note that the converter must be of the same model number.

Step 7. No load parallel system connection:

After determining the parameters of VR1 and VR2, connect the no-load parallel system. If N converters are required, **N** CSC01 are required, and the connection method can be referred to the above **[Connection for Standard Use]**.

Step 8. Remote off:

After connecting the no load parallel system, pull out the entire remote **on/off** control wire and connect it in parallel to a 3V bias so that the parallel system is in the off state.

Step 9. Supply a normal input to the no load parallel system:

After remote off, supply a normal input to the parallel system so that the output is still 0V since it is in the remote off state at that time.

Step 10. Remote on:

(a). Before turning on the parallel converters, the total load current should be lower than the rated current of one converter.

(b). Reduce the remote on/off voltage from 3V to 0V, then remote on the parallel system, output voltage rises from 0V to 1.03 times the rated voltage at no-load.

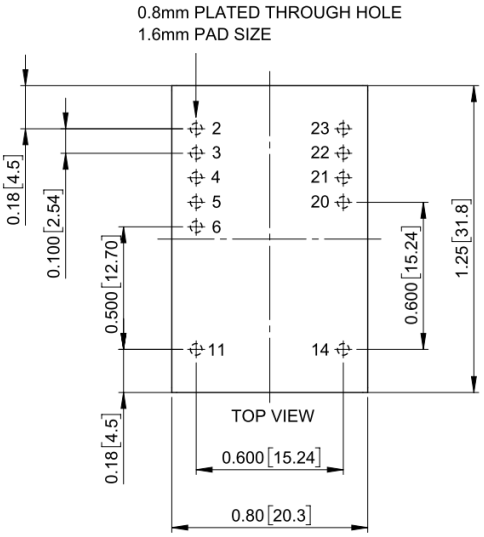
Step 11. Up to the required load:

(a). Please note that the maximum recommended power for a parallel system is 85% of the total power.

(b). Due to the droop voltage technique, the output voltage will drop as the power increases. The voltage is the 0.98 times the rated voltage at 100% load.

6. Recommend Layout, PCB Footprint and Soldering Information

The system designer or end user must ensure that metal and other components in the vicinity of the converter meet the spacing requirements for which the system is approved. Low resistance and inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown below.

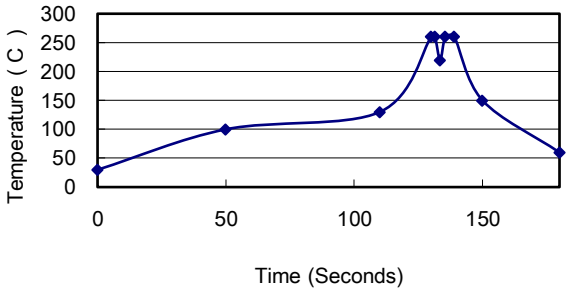


Note: Dimensions are in inches (millimeters)

Clean the soldered side of the module with a brush, prevent liquid from getting into the module. Do not clean by soaking the module into liquid. Do not allow solvent to come in contact with product labels or resin case as this may changed the color of the resin case or cause deletion of the letters printed on the product label. After cleaning, dry the modules well.

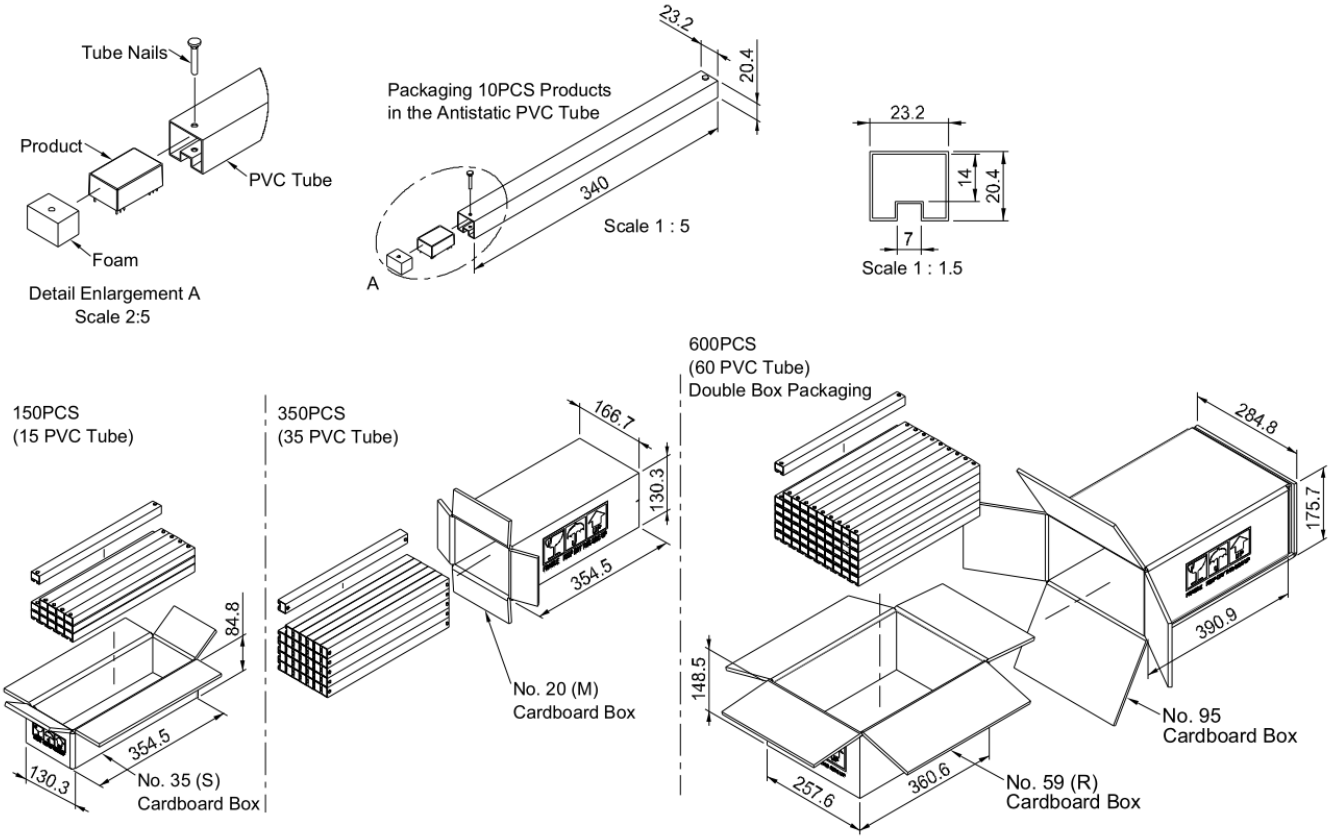
The suggested soldering iron is 420±10℃ for up to 4-10 seconds (less than 90W) used in double PCB and multilayer PCB, The other one is used in the single PCB is 385±10℃ for up to 2-6 seconds (less than 90W). Furthermore the recommended soldering profile is shown below.

Lead Free Wave Soldering Profile



7. Packing Information

The packaging information of CSC01 is as follows:



CINCON ELECTRONICS CO., LTD.

Headquarters:

14F, No.306, Sec.4, Hsin Yi Rd.
Taipei, Taiwan
Tel: 886-2-27086210
Fax: 886-2-27029852
E-mail: sales@cincon.com.tw
Web Site: https://www.cincon.com

Factory:

No. 8-1, Fu Kung Rd.
Fu Hsing Industrial Park
Fu Hsing Hsiang,
Chang Hua Hsien, Taiwan
Tel: 886-4-7690261
Fax: 886-4-7698031

Cincon North America:

1655 Mesa Verde Ave. Ste 180
Ventura, CA 93003
Tel: 805-639-3350
Fax: 805-639-4101
E-mail: info@cincon.com