



## Miniature, 2W, Isolated UNREGULATED DC/DC CONVERTERS

### FEATURES

- Up To 89% Efficiency
- Thermal Protection
- Device-to-Device Synchronization
- SO-28 Power Density of 106W/in<sup>3</sup> (6.5W/cm<sup>3</sup>)
- EN55022 Class B EMC Performance
- UL1950 Recognized Component
- JEDEC 14-Pin and SO-28 Packages

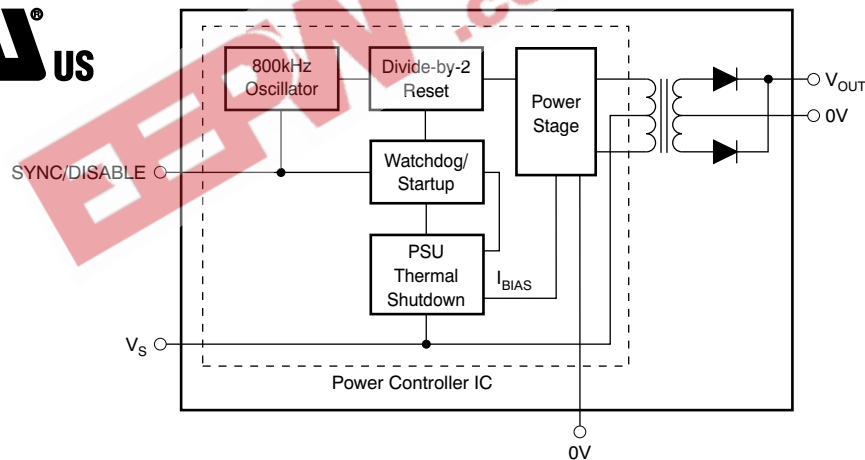
### APPLICATIONS

- Point-of-Use Power Conversion
- Ground Loop Elimination
- Data Acquisition
- Industrial Control and Instrumentation
- Test Equipment

### DESCRIPTION

The DCP02 series is a family of 2W, isolated, unregulated DC/DC converters. Requiring a minimum of external components and including on-chip device protection, the DCP02 series provides extra features such as output disable and synchronization of switching frequencies.

The use of a highly integrated package design results in highly reliable products with power densities of 79W/in<sup>3</sup> (4.8W/cm<sup>3</sup>) for DIP-14, and 106W/in<sup>3</sup> (6.5W/cm<sup>3</sup>) for SO-28. This combination of features and small size makes the DCP02 suitable for a wide range of applications.



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### ORDERING INFORMATION

For the most current package and ordering information, see the Package Option Addendum at the end of this data sheet, or see the TI website at [www.ti.com](http://www.ti.com).

#### Supplemental Ordering Information

Basic Model Number: 2W Product	DCP02	05	05	(D)	( )
Voltage Input:					
5V In					
Voltage Output:					
5V Out					
Dual Output:					
Package Code:					
P = DIP-14					
U = SO-28					

### ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

		DCP02 Series	UNIT
Input Voltage	5V input models	7	V
	12V input models	15	V
	15V input models	18	V
	24V input models	29	V
Storage temperature range		-60 to +125	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

**ELECTRICAL CHARACTERISTICS**At  $T_A = +25^\circ\text{C}$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OUTPUT</b>					
Power	100% full load		2		W
Ripple	O/P capacitor = $1\mu\text{F}$ , 50% load		20		mV <sub>pp</sub>
<b>INPUT</b>					
Voltage range on $V_S$		-10		10	%
<b>ISOLATION</b>					
Voltage	1s Flash test	1			kVrms
	60s test, UL1950 <sup>(1)</sup>	1			kVrms
<b>LINE</b>					
Regulation			1		%/1% of $V_S$
<b>SWITCHING/SYNCHRONIZATION</b>					
Oscillator frequency ( $f_{\text{OSC}}$ )	Switching frequency = $f_{\text{OSC}}/2$		800		kHz
Sync input low		0		0.4	V
Sync input current	$V_{\text{SYNC}} = +2\text{V}$		75		$\mu\text{A}$
Disable time			2		$\mu\text{s}$
Capacitance loading on SYNC pin	External			10	pF
<b>RELIABILITY</b>					
Demonstrated	$T_A = +55^\circ\text{C}$	75			FITS
<b>THERMAL SHUTDOWN</b>					
IC temperature at shutdown			+150		$^\circ\text{C}$
Shutdown current			3		mA
<b>TEMPERATURE RANGE</b>					
Operating		-40		+85	$^\circ\text{C}$

(1) During UL1950 recognition tests only.

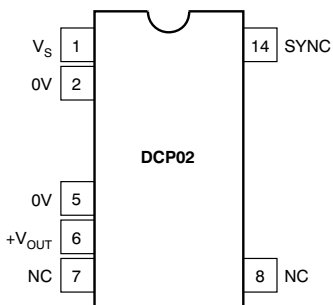
**ELECTRICAL CHARACTERISTICS PER DEVICE**At  $T_A = +25^\circ\text{C}$ , unless otherwise noted.

PRODUCT	INPUT VOLTAGE (V)			OUTPUT VOLTAGE (V)			LOAD REGULATION (%)		NO LOAD CURRENT (mA)	EFFICIENCY (%)	BARRIER CAPACITANCE (pF)
	$V_S$			$V_{\text{NOM}}$					$I_q$		$C_{\text{ISO}}$
				75% LOAD <sup>(1)</sup>			10% TO 100% LOAD		0% LOAD	100% LOAD	$V_{\text{ISO}} = 750\text{Vrms}$
	MIN	TYP	MAX	MIN	TYP	MAX	TYP	MAX	TYP	TYP	TYP
DCP020503P, U	4.5	5	5.5	3.13	3.3	3.46	19	30	18	74	26
DCP020505P, U	4.5	5	5.5	4.75	5	5.25	14	20	18	80	22
DCP020507P, U	4.5	5	5.5	6.65	7	7.35	14	25	20	81	30
DCP020509P, U	4.5	5	5.5	8.55	9	9.45	12	20	23	82	31
DCP020515DP, U	4.5	5	5.5	$\pm 14.25$	$\pm 15$	$\pm 15.75$	11	20	27	85	24
DCP021205P, U	10.8	12	13.2	4.75	5	5.25	7	15	14	83	33
DCP021212P, U	10.8	12	13.2	11.4	12	12.6	7	20	15	87	47
DCP021212DP, U	10.8	12	13.2	$\pm 11.4$	$\pm 12$	$\pm 12.6$	6	20	16	88	35
DCP021215DP, U	10.8	12	13.2	$\pm 14.25$	$\pm 15$	$\pm 15.75$	6	20	21	87	33
DCP021515P, U	13.5	15	16.5	14.25	15	15.75	6	20	15	88	42
DCP022405P	21.6	24	26.4	4.85	5	5.35	6	10	13	81	33
DCP022405U	21.6	24	26.4	4.75	5	5.25	10	15	13	81	33
DCP022405DP, U	21.6	24	26.4	$\pm 4.75$	$\pm 5$	$\pm 5.25$	6	15	12	80	22
DCP022412DP, U	21.6	24	26.4	$\pm 11.4$	$\pm 12$	$\pm 12.6$	4	16	19	83	29
DCP022415DP, U	21.6	24	26.4	$\pm 14.25$	$\pm 15$	$\pm 15.75$	6	25	16	79	44
DCP022418DP, U	21.6	24	26.4	$\pm 17.1$	$\pm 18$	$\pm 18.9$	9	25	20	84	32

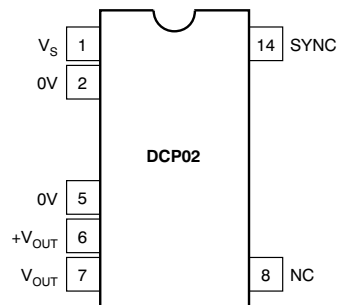
(1) 100% load current =  $2W/V_{\text{NOM}}$  typ.

DEVICE INFORMATION

**NVA PACKAGE  
DIP-14 (Single-DIP)  
(Top View)**



**NVA PACKAGE  
DIP-14 (Dual-DIP)  
(Top View)**



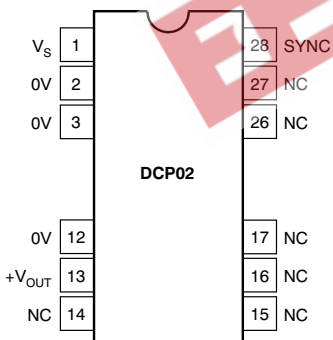
**Table 1. Pin Description (Single-DIP)**

TERMINAL		DESCRIPTION
NAME	NO.	
V <sub>S</sub>	1	Voltage input
0V	2	Input side common
0V	5	Output side common
+V <sub>OUT</sub>	6	+Voltage out
NC	7, 8	Not connected
SYNC	14	Synchronization pin

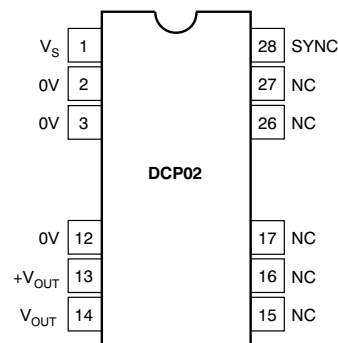
**Table 3. TERMINAL FUNCTIONS (Dual-DIP)**

TERMINAL		DESCRIPTION
NAME	NO.	
V <sub>S</sub>	1	Voltage input
0V	2	Input side common
0V	5	Output side common
+V <sub>OUT</sub>	6	+Voltage out
-V <sub>OUT</sub>	7	-Voltage out
NC	8	Not connected
SYNC	14	Synchronization pin

**DVB PACKAGE  
SO-28 (Single-SO)  
(Top View)**



**DVB PACKAGE  
SO-28 (Dual-SO)  
(Top View)**



**Table 2. TERMINAL FUNCTIONS (Single-SO)**

TERMINAL		DESCRIPTION
NAME	NO.	
V <sub>S</sub>	1	Voltage input
0V	2	Input side common
0V	3	Input side common
0V	12	Output side common
+V <sub>OUT</sub>	13	+Voltage out
NC	14, 15, 16, 17, 26, 27	Not connected
SYNC	28	Synchronization pin

**Table 4. TERMINAL FUNCTIONS (Dual-SO)**

TERMINAL		DESCRIPTION
NAME	NO.	
V <sub>S</sub>	1	Voltage input
0V	2	Input side common
0V	3	Input side common
0V	12	Output side common
+V <sub>OUT</sub>	13	+Voltage out
-V <sub>OUT</sub>	14	-Voltage out
NC	15, 16, 17, 26, 27	Not connected
SYNC	28	Synchronization pin

**TYPICAL CHARACTERISTICS**

At  $T_A = +25^\circ\text{C}$ , unless otherwise noted.

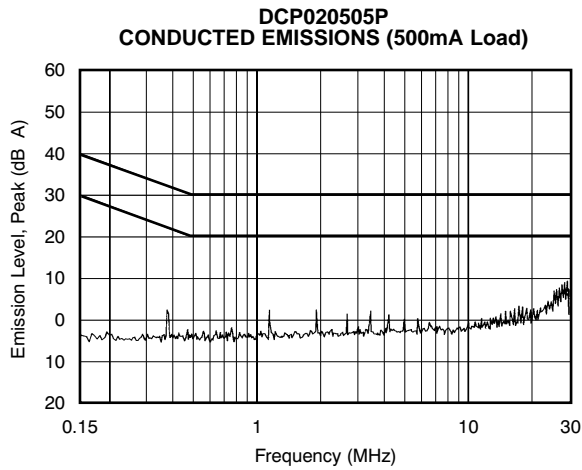


Figure 1.

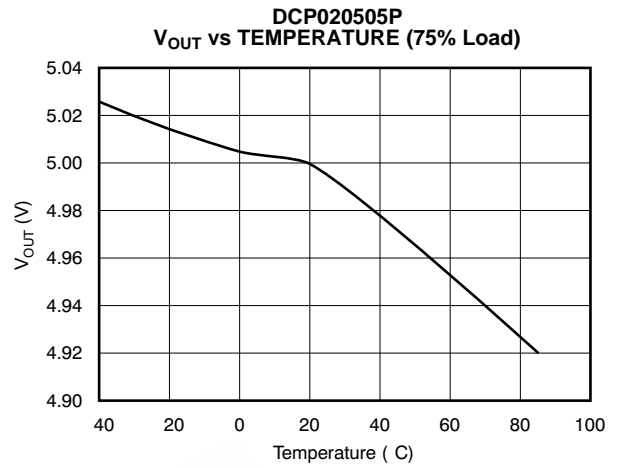


Figure 2.

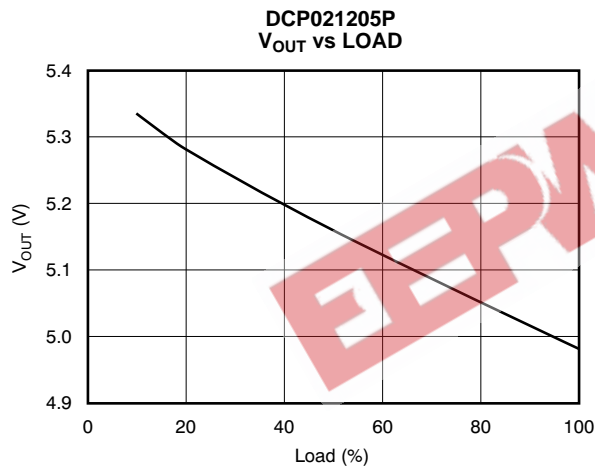


Figure 3.

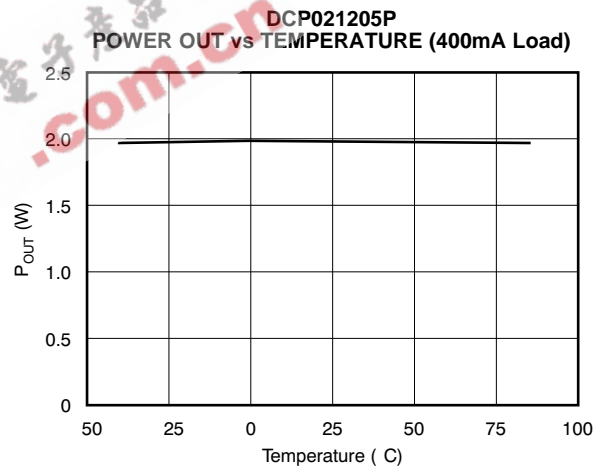


Figure 4.

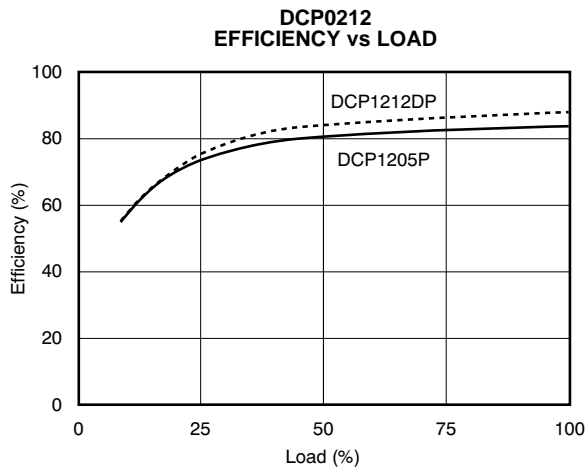


Figure 5.

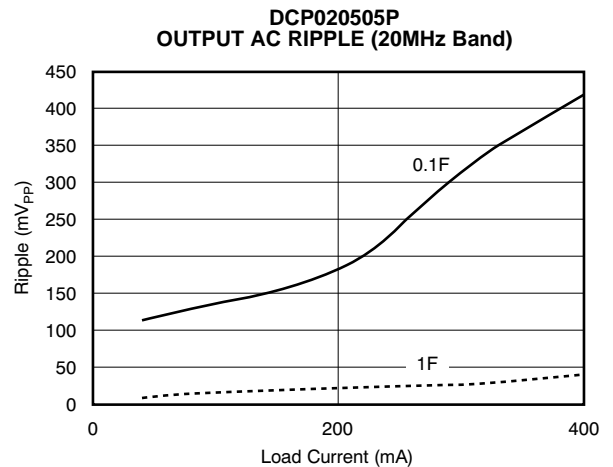


Figure 6.

## FUNCTIONAL DESCRIPTION

### OVERVIEW

The DCP02 offers up to 2W of unregulated output power from a 5V, 12V, 15V, or 24V input source with a typical efficiency of up to 89%. This is achieved through highly integrated packaging technology and the implementation of a custom power stage and control IC. The circuit design uses an advanced BiCMOS/DMOS process.

### POWER STAGE

The DCP02 uses a push-pull, center-tapped topology switching at 400kHz (divide-by-2 from an 800kHz oscillator).

### OSCILLATOR AND WATCHDOG

The onboard 800kHz oscillator generates the switching frequency via a divide-by-2 circuit. The oscillator can be synchronized to other DCP02 circuits or an external source, and is used to minimize system noise.

A watchdog circuit checks the operation of the oscillator circuit. The oscillator can be stopped by pulling the SYNC pin low. The output pins will be tri-stated. This will occur in 2 $\mu$ s.

### THERMAL SHUTDOWN

The DCP02 is protected by a thermal-shutdown circuit. If the on-chip temperature exceeds +150°C, the device will shut down. Once the temperature falls below +150°C, normal operation will resume.

### SYNCHRONIZATION

In the event that more than one DC/DC converter is needed onboard, beat frequencies and other electrical interference can be generated.

This is due to the small variations in switching frequencies between the DC/DC converters.

The DCP02 overcomes this by allowing devices to be synchronized to one another. Up to eight devices can be synchronized by connecting the SYNC pins together, taking care to minimize the capacitance of tracking. Stray capacitance (> 10pF) will have the effect of reducing the switching frequency, or even stopping the oscillator circuit. It is also recommended that power and ground lines be star-connected.

It should be noted that if synchronized devices are used at start up, all devices will draw maximum current simultaneously. This can cause the input voltage to dip, and if it dips below the minimum input voltage (4.5V), the devices may not start up. A 2.2 $\mu$ F capacitor should be connected close to the input pins.

If more than eight devices are to be synchronized, it is recommended that the SYNC pins be driven by an external device. Details are contained in Application Report [SBAA035](#), *External Synchronization of the DCP01/02 Series of DC/DC Converters*, available for download from [www.ti.com](http://www.ti.com).

### CONSTRUCTION

The basic construction of the DCP02 is the same as standard ICs. There is no substrate within the molded package. The DCP02 is constructed using an IC, rectifier diodes, and a wound magnetic toroid on a leadframe. Since there is no solder within the package, the DCP02 does not require any special printed circuit board (PCB) assembly processing. This results in an isolated DC/DC converter with inherently high reliability.

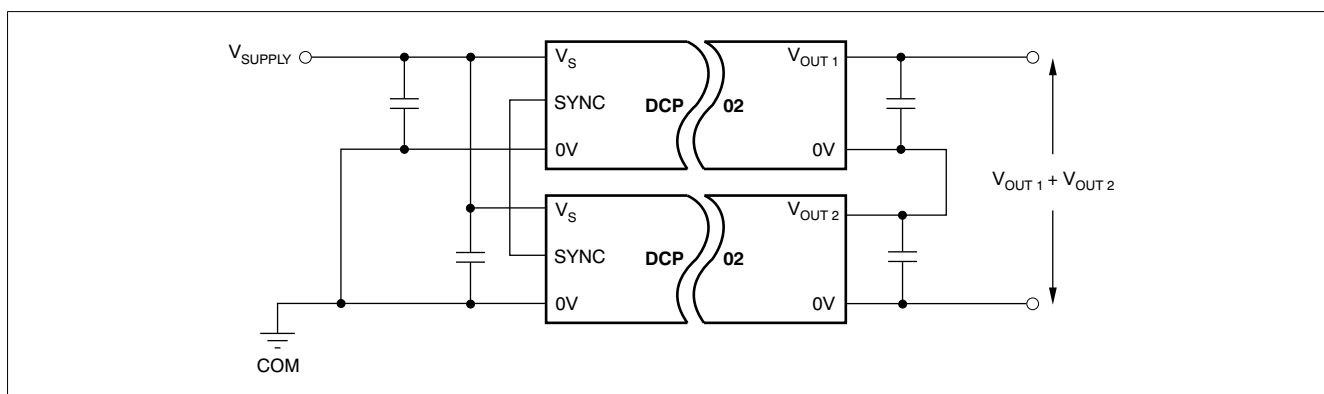


Figure 7. Connecting the DCP02 in Series

## ADDITIONAL FUNCTIONS

### DISABLE/ENABLE

The DCP02 can be disabled or enabled by driving the SYNC pin using an open drain CMOS gate. If the SYNC pin is pulled low, the DCP02 will be disabled. The disable time depends upon the external loading; the internal disable function is implemented in 2 $\mu$ s. Removal of the pull down will cause the DCP02 to be enabled.

Capacitive loading on the SYNC pin should be minimized in order to prevent a reduction in the oscillator frequency.

### DECOUPLING

#### Ripple Reduction

The high switching frequency of 400kHz allows simple filtering. To reduce ripple, it is recommended that a 1 $\mu$ F capacitor be used on  $V_{OUT}$ . Dual outputs should both be decoupled to pin 5. A 2.2 $\mu$ F capacitor on the input is recommended.

### Connecting the DCP02 in Series

Multiple DCP02 isolated 2W DC/DC converters can be connected in series to provide nonstandard voltage rails. This is possible by using the floating outputs provided by the galvanic isolation of the DCP02.

Connect the positive  $V_{OUT}$  from one DCP02 to the negative  $V_{OUT}$  (0V) of another (see Figure 7). If the SYNC pins are tied together, the self-synchronization feature of the DCP02 will prevent beat frequencies on the voltage rails. The SYNC feature of the DCP02 allows easy series connection without external filtering, thus minimizing cost.

The outputs on the dual-output DCP02 versions can also be connected in series to provide two times the magnitude of  $V_{OUT}$ , as shown in Figure 8. For example, a dual 15V DCP022415D could be connected to provide a 30V rail.

### Connecting the DCP02 in Parallel

If the output power from one DCP02 is not sufficient, it is possible to parallel the outputs of multiple DCP02s, as shown in Figure 9. Again, the SYNC feature allows easy synchronization to prevent power-rail beat frequencies at no additional filtering cost.

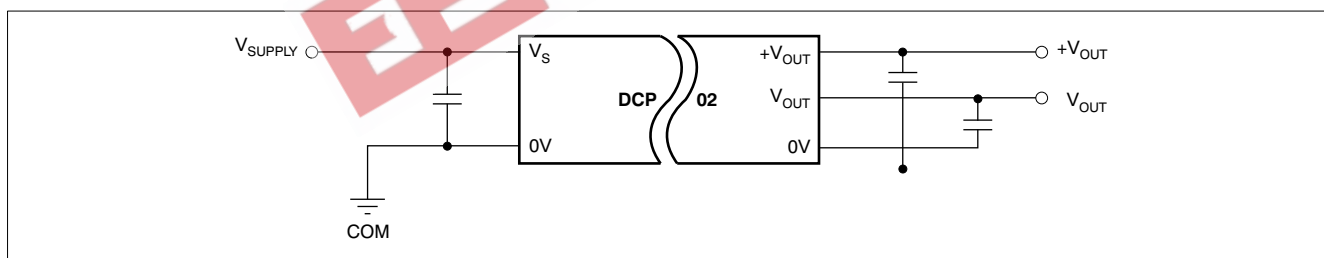


Figure 8. Connecting Dual Outputs in Series

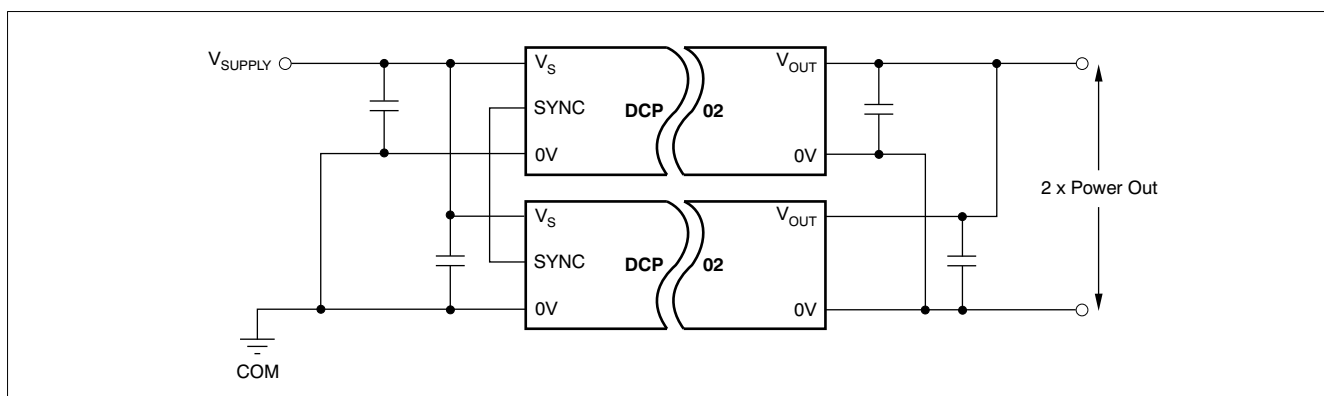


Figure 9. Connecting Multiple DCP02s in Parallel

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Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265