

Miniature, 2W, Isolated UNREGULATED DC/DC CONVERTERS

FEATURES

- Up To 89% Efficiency
- Thermal Protection
- Device-to-Device Synchronization
- SO-28 Power Density of 106W/in³ (6.5W/cm³)
- EN55022 Class B EMC Performance
- UL1950 Recognized Component
- JEDEC 14-Pin and SO-28 Packages

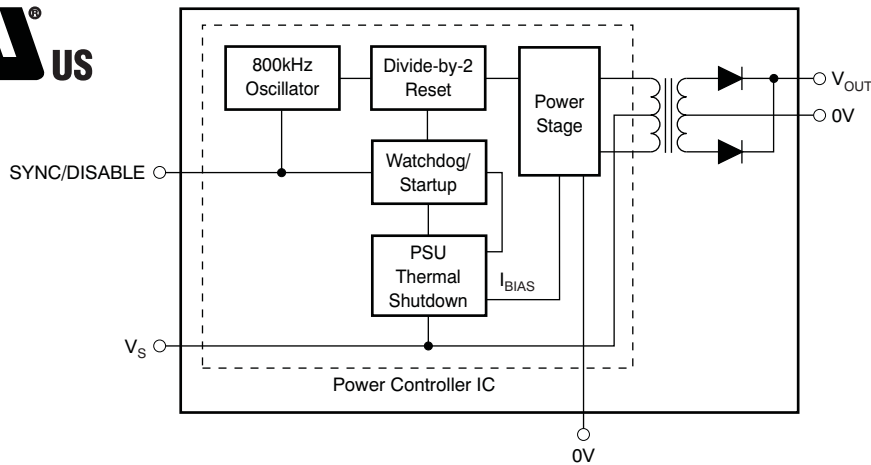
APPLICATIONS

- 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/in³ (4.8W/cm³) for DIP-14, and 106W/in³ (6.5W/cm³) for SO-28. This combination of features and small size makes the DCP02 suitable for a wide range of applications.



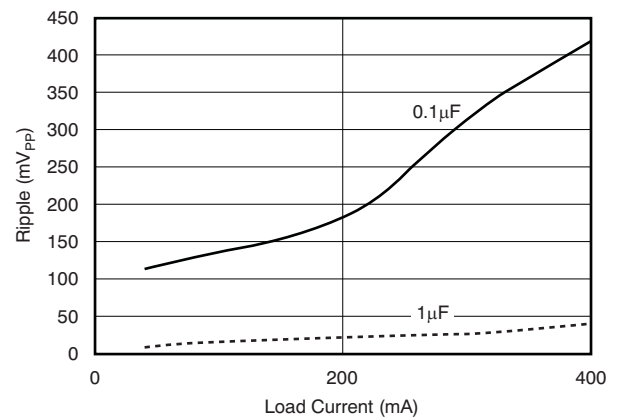
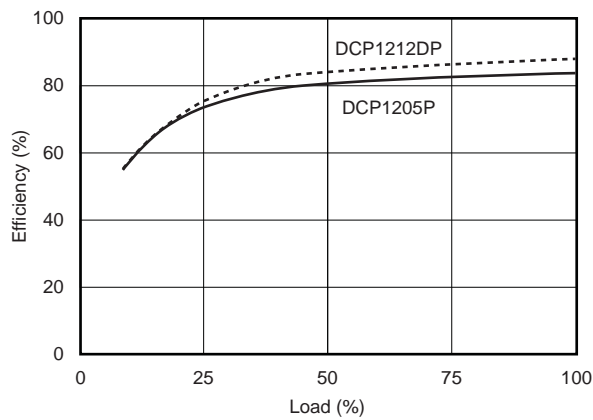
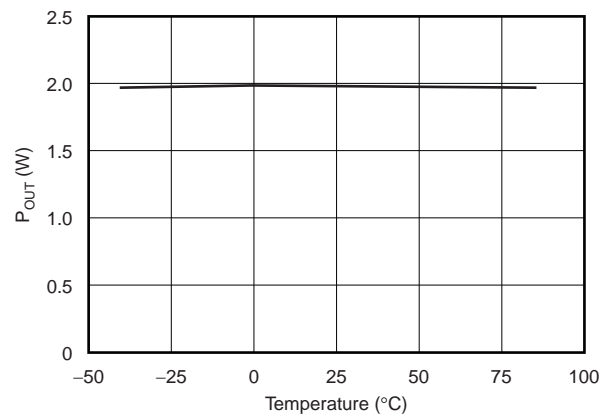
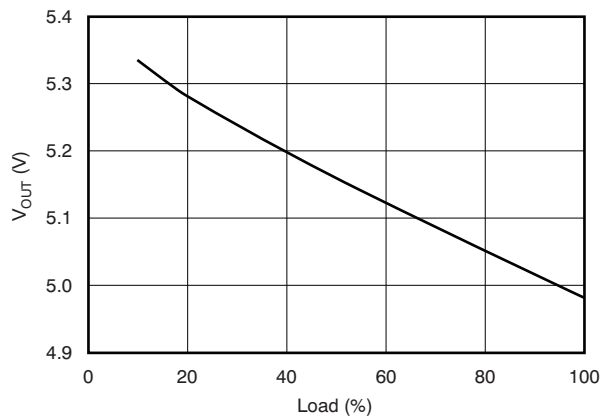
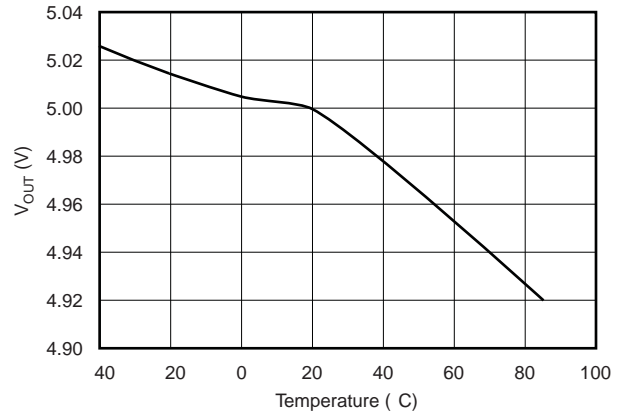
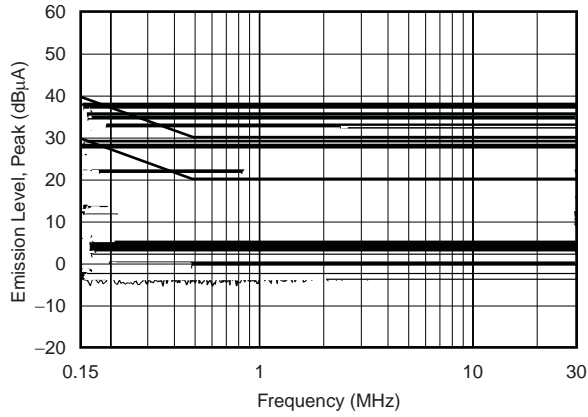
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TYPICAL CHARACTERISTICS

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

DCP020505P



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 efficiency 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, which occurs in 2 μ 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 resumes.

SYNCHRONIZATION

This interference occurs because of the small variations in switching frequencies between the DC/DC converters.

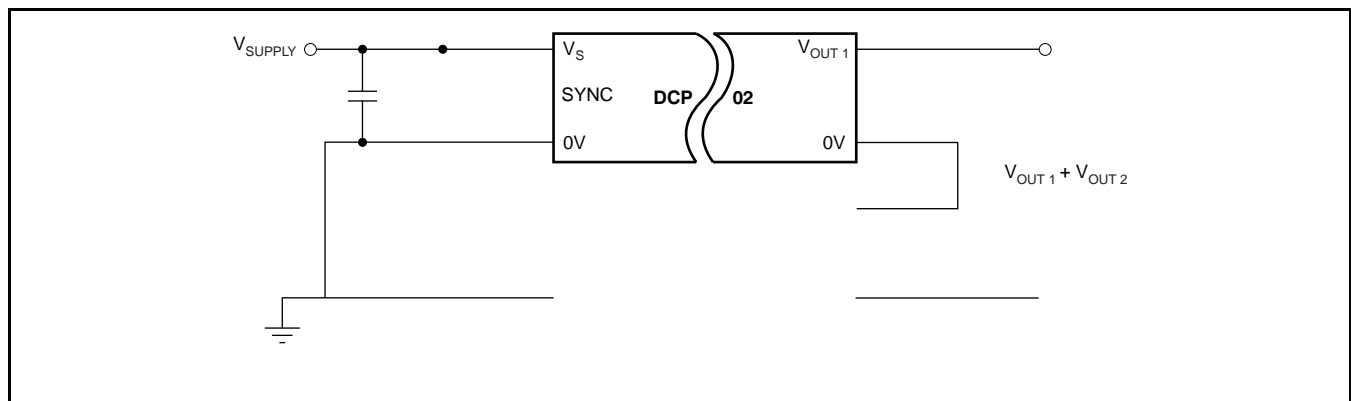
The DCP02 overcomes this interference by allowing devices to be synchronized to one another. Up to eight devices can be synchronized by connecting the SYNC pins together, taking care to minimize the capacitance of tracking. Stray capacitance (> 10pF) has the effect of reducing the switching frequency, 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 configuration can cause the input voltage to dip; if it dips below the minimum input voltage (4.5V), the devices may not start up. A 2.2 μ 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.

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



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 μ s. Removal of the pull down causes 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 μ F capacitor be used on V_{OUT}. Dual outputs should both be decoupled to pin 5. A 2.2 μ F capacitor on the input is also recommended.

Connecting the DCP02 in Series

Multiple DCP02 isolated 2W DC/DC converters can be connected in series to provide nonstandard voltage rails. This configuration 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 prevents 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.

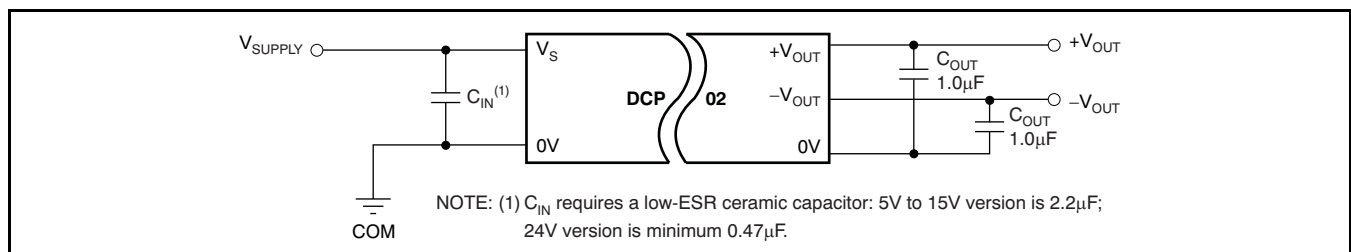


Figure 8. Connecting Dual Outputs in Series



Figure 9. Connecting Multiple DCP02s in Parallel

APPLICATION INFORMATION

The [DCP01B](#), [DCV01](#), and DCP02 are three families of miniature DC/DC converters providing an isolated unregulated voltage output. All are fabricated using a CMOS/DMOS process with the DCP01B replacing the familiar DCP01 family that was fabricated from a bipolar process. The DCP02 is essentially an extension of the DCP01B family, providing a higher power output with a significantly improved

OPTIMIZING PERFORMANCE

Optimum performance can only be achieved if the device is correctly supported. The very nature of a switching converter requires power to be instantly available when it switches on. If the converter has DMOS switching transistors, the fast edges will create

TRANSFORMER DRIVE CIRCUIT

SELF-SYNCHRONIZATION

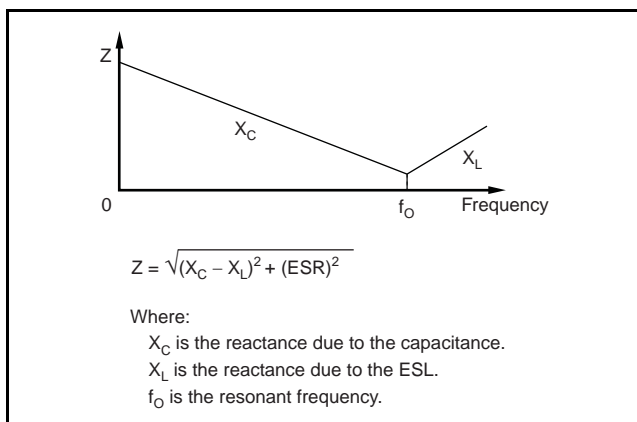
PCB Design

Decoupling Ceramic Capacitors

All capacitors have losses because of internal equivalent series resistance (ESR), and to a lesser degree, equivalent series inductance (ESL). Values for ESL are not always easy to obtain. However,

Input Capacitor and the Effects of ESR

If the input decoupling capacitor is not ceramic with <20m ESR, then at the instant the power transistors switch on, the voltage at the input pins falls momentarily. Should the voltage



Clearly, increasing the capacitance has a much smaller effect on the output ripple voltage than does reducing the value of the ESR for the filter capacitor.

DUAL OUTPUT VOLTAGE DCP AND DCVs

The voltage output for the dual DCPs is half wave rectified; therefore, the discharge time is 1.25 μ s. Repeating the above calculations using the 100% load resistance of 25 Ω (0.2A per output), the results are:

$$\tau = 25\mu\text{s}$$

$$t_{\text{DIS}} = 1.25\mu\text{s}$$

$$V_{\text{DIS}} = 244\text{mV}$$

$$V_{\text{ESR}} = 20\text{mV}$$

$$\text{Ripple Voltage} = 266\text{mV}$$

This time, it is the capacitor discharging that contributes to the largest component of ripple. Changing the output filter to 10 μ F, and repeating the calculations, the result is:

$$\text{Ripple Voltage} = 45\text{mV}.$$

This value is composed of almost equal components.

The previous calculations are given only as a guide. Capacitor

PCB LAYOUT

The SYNC_{IN} pin, when not being used, is best left as a floating pad. A ground ring or annulus connected around the pin prevents noise being conducted onto the pin. If the SYNC_{IN} pin is to be connected to one or more SYNC_{IN} pins, then the linking trace should be narrow and must be kept short in length. In addition, no other trace should be in close proximity to this trace because that will increase the stray capacitance on this pin. In turn, the stray capacitance affects the performance of the oscillator.

Ripple and Noise

Careful consideration should be given to the layout of the PCB in order to obtain the best results.

The DCP02 is a switching power supply, and as such can place high peak current demands on the input supply. In order to avoid the supply falling momentarily during the fast switching pulses, ground and power planes should be used to connect the power to the input of DCP02. If this connection is not possible, then the supplies must be connected in a star formation with the traces made as wide as possible.

If the SYNC_{IN} pin is being used, then the trace

THERMAL MANAGEMENT

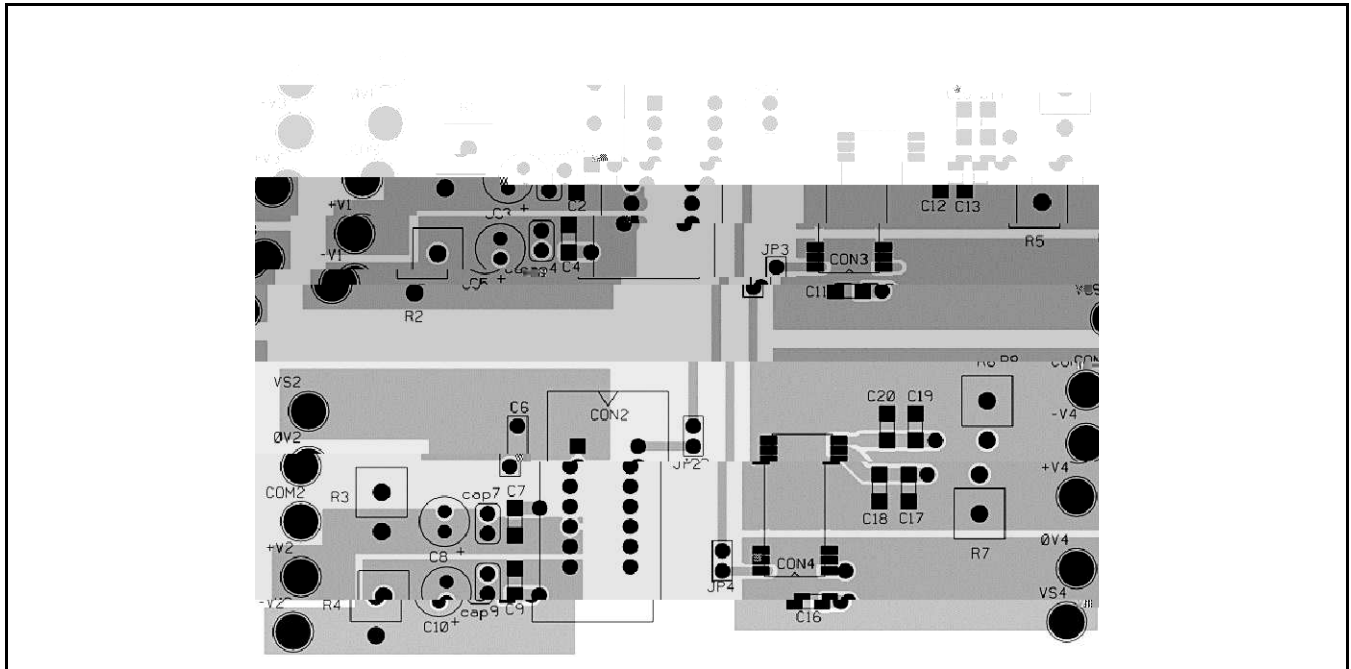


Figure 11. Example of PCB Layout, Component-Side View

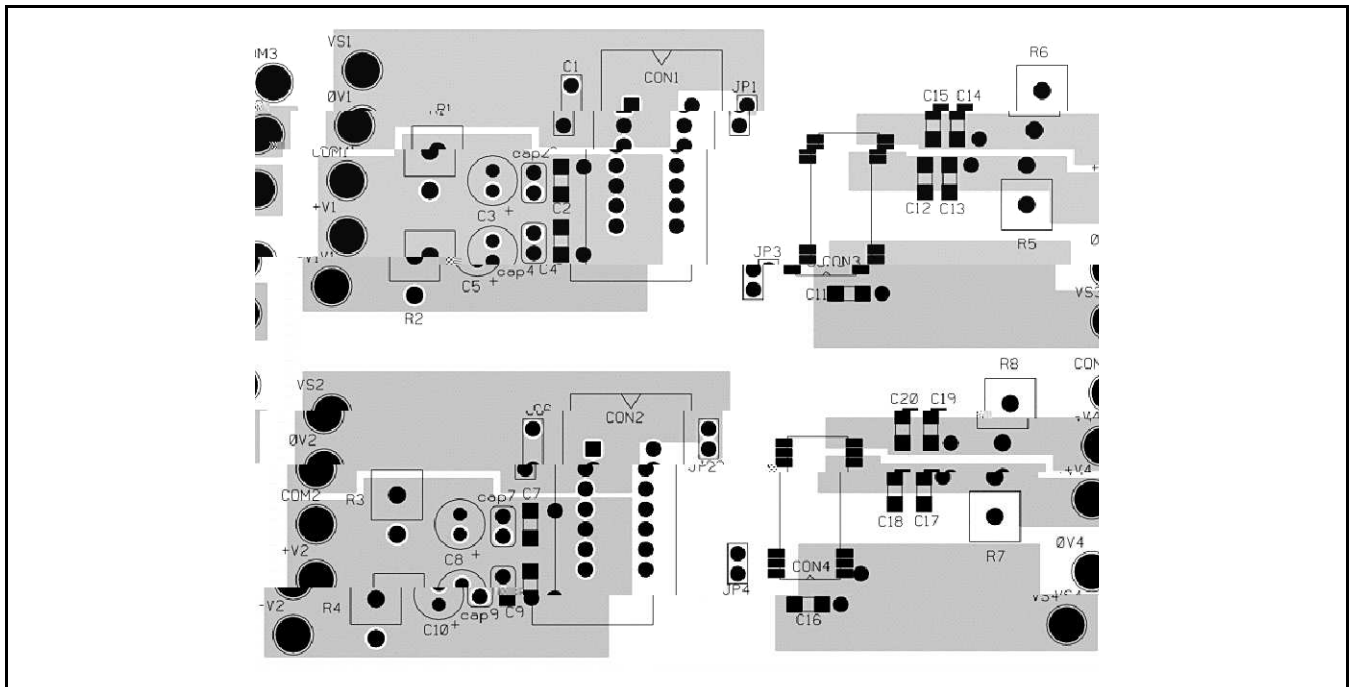


Figure 12. Example of PCB Layout, Non-Component-Side View

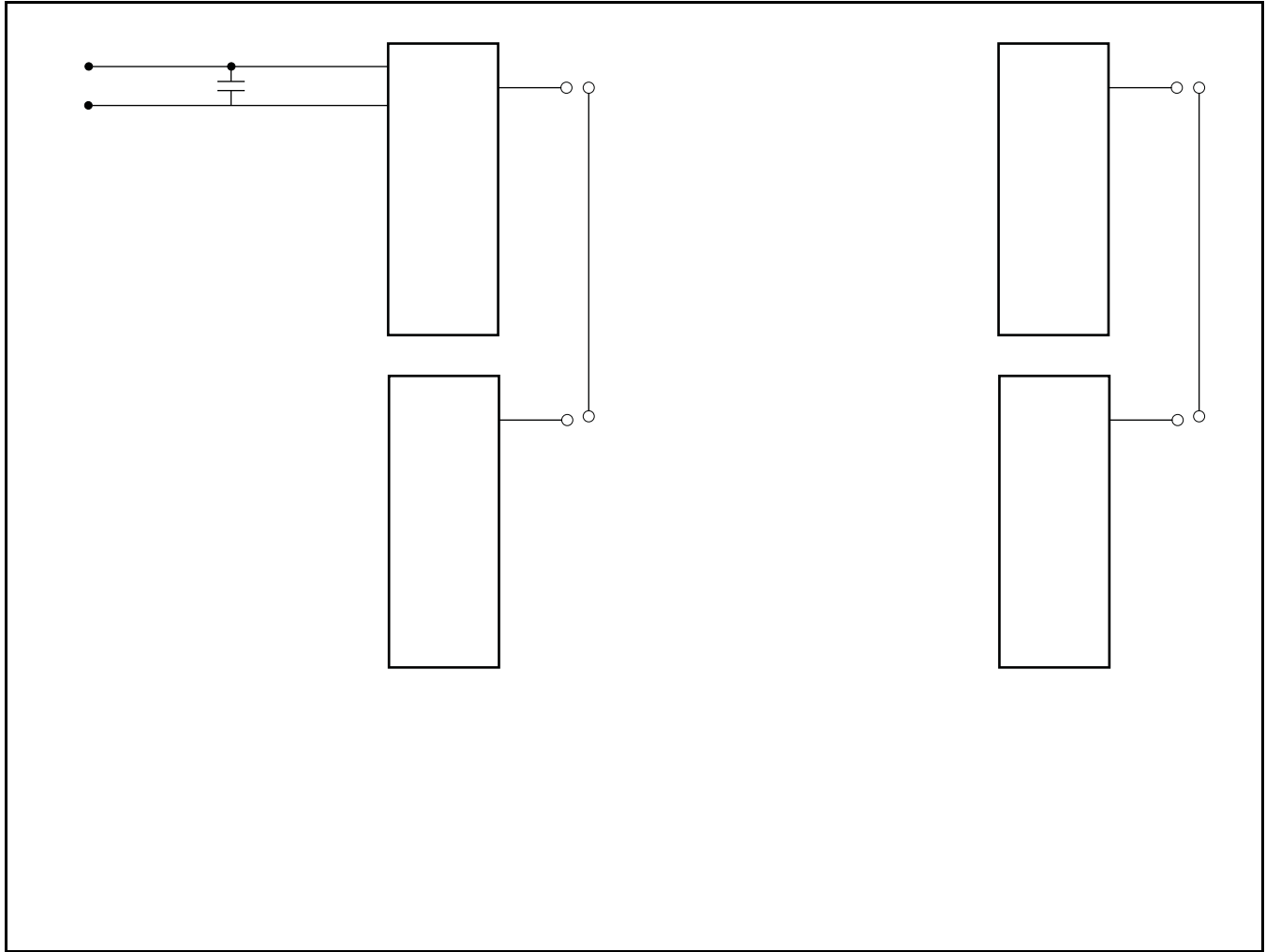


Figure 13. Example of PCB Layout, Schematic Diagram



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PACKAGE OPTION ADDENDUM

28-Aug-2010

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
DCP020503P	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP020503U	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP020505P	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP020505U	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP020505U/1K	ACTIVE	SOP	DVB	12	1000	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Purchase Samples
DCP020505U/1KE4	ACTIVE	SOP	DVB	12	1000	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Purchase Samples
DCP020505UE4	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP020507P	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP020507U	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP020507U/1K	ACTIVE	SOP	DVB	12	1000	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Purchase Samples
DCP020509P	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP020509U	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP020509U/1K	OBSOLETE	SOP	DVB	12		TBD	Call TI	Call TI	



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PACKAGE OPTION ADDENDUM

28-Aug-2010

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
DCP022405DP	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP022405DU	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Purchase Samples
DCP022405P	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP022405U	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP022415DP	ACTIVE	PDIP	NVA	7	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	Request Free Samples
DCP022415DU	ACTIVE	SOP	DVB	12	28	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Request Free Samples
DCP022415DU/1K	ACTIVE	SOP	DVB	12	1000	Pb-Free (RoHS)	CU NIPDAU	Level-3-260C-168 HR	Purchase Samples

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that

DVB(R-PDSO-G12/28)

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