UNITRODE

Design Note

UCC3981 USB Power Controller IC, Evaluation Board, Schematic, and List of Materials

By Chuck Melchin

Introduction

The UCC3981 Power Controller is designed to provide a self powered USB hub with a local 3.3V regulated voltage as well as four 5V regulated voltages for USB ports. The 3.3V linear regulator is used to provide power to a local USB microcontroller. The 5V outputs are current limited to 500mA and the 3.3V output to 100mA in full compliance with USB specifications.

This demonstration kit provides all the circuitry necessary to evaluate the performance of the UCC3981 in a typical application. Each of the 5V outputs, as well as the 3.3V microcontroller voltage, can be individually enabled for optimal port control. Output enable is accomplished by the use of a five-position dipswitch and overcurrent signals are pulled up to the input voltage through 10KΩ resistors. Both enable and overcurrent signals are available at a 10 position in line SIP for easy scope probe access. The demo kit utilizes an external NMOS switch in a low dropout linear regulator for pre-regulating a rough DC voltage, such as a filament voltage, to provide the 5.5V input to the four 5V linear regulators.

This kit can also provide a valid means of evaluating the UCC39811 in a typical application circuit. The UCC39811 is intended to perform the same tasks as the UCC3981 with the exception of providing the gate drive and control circuitry for the 5.5V preregulator. The preregulator function can be bypassed by providing 5.5V externally at VREG, removing Q1 and replacing C09 with a 0.1μF ceramic capacitor. In this case VFIL and VHUB should also be connected to the 5.5V supply providing DC bias for the 3.3V regulator and the gate drive for the internal 5V regulators.

TESTING PROCEDURE

1. Set all enable switches to the “off” position. SW1 switches 1-4 correspond to outputs ENA-D respectively. Switch 5 controls ENHUB.
2. Supply a minimum of 6V, maximum of 9V, from a 2A minimum supply to the V_{FIL} banana jack. Apply a 5V, 500mA supply to the V_{HUB} banana jack. Connect grounds for both supplies to the demonstration kit ground. Ensure the maximum voltage of 9V is not exceeded on either the V_{FIL} or V_{HUB} pins.
3. Connect a voltmeter to the VREG output. The voltage should read approximately 5.5V.
4. Connect the voltmeter to the V5A output. The output voltage should read approximately 0V.
5. Set the enable switch (ENA) for V5A to the “on” position. The output voltage should read approximately 5V. The corresponding enable pin of the 10 position SIP should transition from a low to a high.
6. Repeat steps 4 and 5 for outputs V5B – V5D and the 3.3V output.
7. Apply variable resistive loads to all outputs. Increase the loads sequentially to approximately 500mA on the 5V outputs, and 100mA on the 3.3V output. The appropriate overcurrent flags on the 10 position SIP should transition from a high to a low as each output reaches its overcurrent condition. Reset each load to its nominal value after observing each output’s overcurrent flag to prevent thermal problems with the device. The overcurrent flags would normally signal the USB controller of the overcurrent condition and the controller would shut down the appropriate output in an actual application. The overcurrent flags should return to a logic high once the load is reset to its nominal value.
8. Reset the enable switch for each output. The corresponding output voltages should read approximately 0V.
9. Power down the input supplies.

If the testing procedure is successfully completed the demonstration kit is verified to be functional and is ready for more rigorous and application specific evaluation to be performed.

For more complete information, pin descriptions and specifications for the UCC3981 USB power controller IC, please refer to the UCC3981 data sheet or contact your Unitrode Field Applications Engineer.

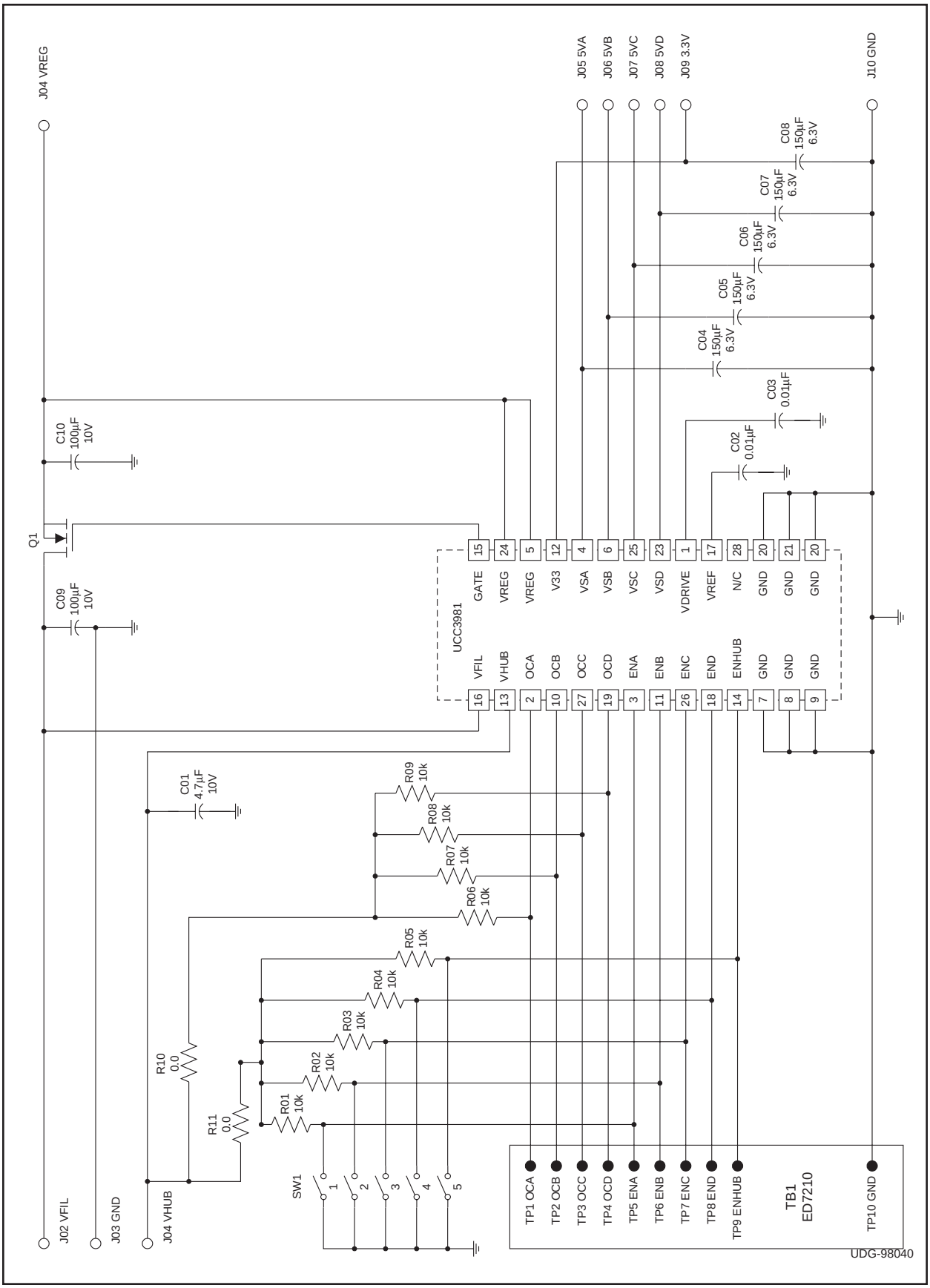

Figure 1. UCC3981 evaluation board schematic.

Notes:

1) *Absolute Maximum voltage for VHUB is 9.0V*
2) *Absolute Maximum voltage for VFIL is 9.0V*
3) *VHUB and VFIL can be connected together*
4) *Pregulator can be bypassed by providing 5.5V at VREG and VFIL, removing Q1 and replacing C09 with a 0.1 F Ceramic capacitor.*
5) *ENABLE and OVERCURRENT signals are pulled up to VHUB. 0 jumpers R10 and R11 can be removed to wire pullups to a different voltage*
6) *Capacitors C04 through C10 can be replaced with size "D" Tantalum SMD capacitors.*
7) *Capacitor C01 can be replaced with size "B" Tantalum SMD capacitors.*

Reference Designator	Description	Manufacturer	Part Number
R01–R09	10k, 5%, 1/8W, Metal Film Resistor		
R10, R11	0.0W, 5%, Jumper, Metal Film Resistor		
TB1	Pin Header, 10 position	Mill-Max	ED7210
SW1	DIP Switch, 5 Position, SPST	AMP	A5205
C01	4.7µF, 10V, Tantalum Capacitor		
C02, C03	0.01µF, Z5U, Ceramic Capacitor		
C04–C08	150µF, 6.3V, Electrolytic Capacitor		
C09, C10	100µF, 10V, Electrolytic Capacitor		
J01–J10	Binding Post		
U1	USB Power Controller IC	Unitrode	UCC3981
Q1	60V, 17A, N-Channel MOSFET	International Rectifier	IRFZ24

Table 1. UCC3981 evaluation board list of materials.

Note: UCC3981 is also the UCC3831. UCC39811 was formerly UCC38531.

UNITRODE CORPORATION
7 CONTINENTAL BLVD. • MERRIMACK, NH 03054
TEL. (603) 424-2410 • FAX (603) 424-3460

UNITRODE

Design Note

UCC3981 USB Power Controller IC, Evaluation Board, Schematic, and List of Materials

By Chuck Melchin

Introduction

The UCC3981 Power Controller is designed to provide a self powered USB hub with a local 3.3V regulated voltage as well as four 5V regulated voltages for USB ports. The 3.3V linear regulator is used to provide power to a local USB microcontroller. The 5V outputs are current limited to 500mA and the 3.3V output to 100mA in full compliance with USB specifications.

This demonstration kit provides all the circuitry necessary to evaluate the performance of the UCC3981 in a typical application. Each of the 5V outputs, as well as the 3.3V microcontroller voltage, can be individually enabled for optimal port control. Output enable is accomplished by the use of a five-position dipswitch and overcurrent signals are pulled up to the input voltage through 10KΩ resistors. Both enable and overcurrent signals are available at a 10 position in line SIP for easy scope probe access. The demo kit utilizes an external NMOS switch in a low dropout linear regulator for pre-regulating a rough DC voltage, such as a filament voltage, to provide the 5.5V input to the four 5V linear regulators.

This kit can also provide a valid means of evaluating the UCC39811 in a typical application circuit. The UCC39811 is intended to perform the same tasks as the UCC3981 with the exception of providing the gate drive and control circuitry for the 5.5V preregulator. The preregulator function can be bypassed by providing 5.5V externally at VREG, removing Q1 and replacing C09 with a 0.1μF ceramic capacitor. In this case VFIL and VHUB should also be connected to the 5.5V supply providing DC bias for the 3.3V regulator and the gate drive for the internal 5V regulators.

TESTING PROCEDURE

1. Set all enable switches to the “off” position. SW1 switches 1-4 correspond to outputs ENA-D respectively. Switch 5 controls ENHUB.
2. Supply a minimum of 6V, maximum of 9V, from a 2A minimum supply to the V_{FIL} banana jack. Apply a 5V, 500mA supply to the V_{HUB} banana jack. Connect grounds for both supplies to the demonstration kit ground. Ensure the maximum voltage of 9V is not exceeded on either the V_{FIL} or V_{HUB} pins.
3. Connect a voltmeter to the VREG output. The voltage should read approximately 5.5V.
4. Connect the voltmeter to the V5A output. The output voltage should read approximately 0V.
5. Set the enable switch (ENA) for V5A to the “on” position. The output voltage should read approximately 5V. The corresponding enable pin of the 10 position SIP should transition from a low to a high.
6. Repeat steps 4 and 5 for outputs V5B – V5D and the 3.3V output.
7. Apply variable resistive loads to all outputs. Increase the loads sequentially to approximately 500mA on the 5V outputs, and 100mA on the 3.3V output. The appropriate overcurrent flags on the 10 position SIP should transition from a high to a low as each output reaches its overcurrent condition. Reset each load to its nominal value after observing each output’s overcurrent flag to prevent thermal problems with the device. The overcurrent flags would normally signal the USB controller of the overcurrent condition and the controller would shut down the appropriate output in an actual application. The overcurrent flags should return to a logic high once the load is reset to its nominal value.
8. Reset the enable switch for each output. The corresponding output voltages should read approximately 0V.
9. Power down the input supplies.

If the testing procedure is successfully completed the demonstration kit is verified to be functional and is ready for more rigorous and application specific evaluation to be performed.

For more complete information, pin descriptions and specifications for the UCC3981 USB power controller IC, please refer to the UCC3981 data sheet or contact your Unitrode Field Applications Engineer.

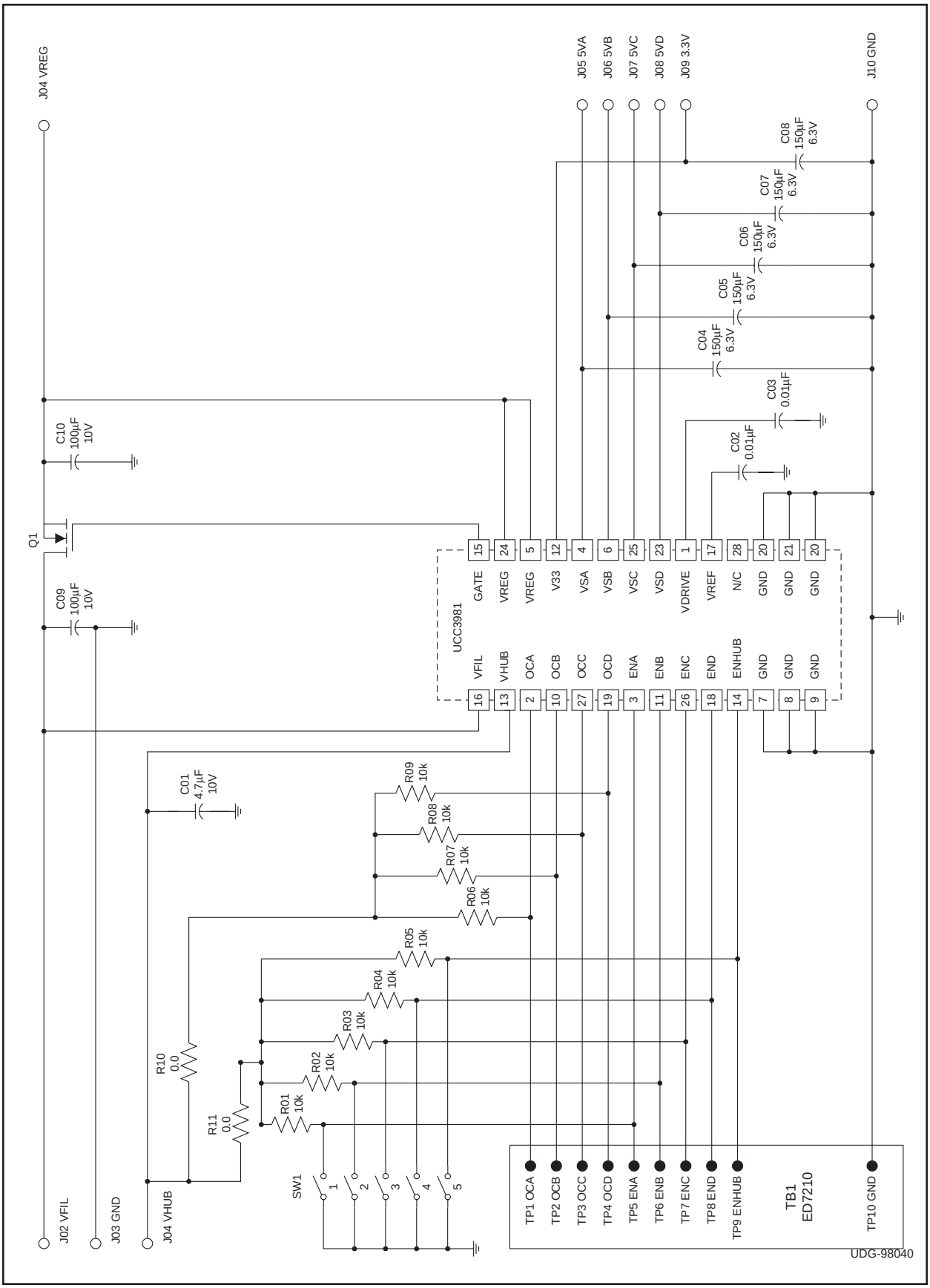

Figure 1. UCC3981 evaluation board schematic.

Notes:

1) *Absolute Maximum voltage for VHUB is 9.0V*
2) *Absolute Maximum voltage for VFIL is 9.0V*
3) *VHUB and VFIL can be connected together*
4) *Pregulator can be bypassed by providing 5.5V at VREG and VFIL, removing Q1 and replacing C09 with a 0.1 F Ceramic capacitor.*
5) *ENABLE and OVERCURRENT signals are pulled up to VHUB. 0 jumpers R10 and R11 can be removed to wire pullups to a different voltage*
6) *Capacitors C04 through C10 can be replaced with size "D" Tantalum SMD capacitors.*
7) *Capacitor C01 can be replaced with size "B" Tantalum SMD capacitors.*

Reference Designator	Description	Manufacturer	Part Number
R01–R09	10k, 5%, 1/8W, Metal Film Resistor		
R10, R11	0.0W, 5%, Jumper, Metal Film Resistor		
TB1	Pin Header, 10 position	Mill-Max	ED7210
SW1	DIP Switch, 5 Position, SPST	AMP	A5205
C01	4.7µF, 10V, Tantalum Capacitor		
C02, C03	0.01µF, Z5U, Ceramic Capacitor		
C04–C08	150µF, 6.3V, Electrolytic Capacitor		
C09, C10	100µF, 10V, Electrolytic Capacitor		
J01–J10	Binding Post		
U1	USB Power Controller IC	Unitrode	UCC3981
Q1	60V, 17A, N-Channel MOSFET	International Rectifier	IRFZ24

Table 1. UCC3981 evaluation board list of materials.

Note: UCC3981 is also the UCC3831. UCC39811 was formerly UCC38531.

UNITRODE CORPORATION
7 CONTINENTAL BLVD. • MERRIMACK, NH 03054
TEL. (603) 424-2410 • FAX (603) 424-3460

UNITRODE

Design Note

UCC3981 USB Power Controller IC, Evaluation Board, Schematic, and List of Materials

By Chuck Melchin

Introduction

The UCC3981 Power Controller is designed to provide a self powered USB hub with a local 3.3V regulated voltage as well as four 5V regulated voltages for USB ports. The 3.3V linear regulator is used to provide power to a local USB microcontroller. The 5V outputs are current limited to 500mA and the 3.3V output to 100mA in full compliance with USB specifications.

This demonstration kit provides all the circuitry necessary to evaluate the performance of the UCC3981 in a typical application. Each of the 5V outputs, as well as the 3.3V microcontroller voltage, can be individually enabled for optimal port control. Output enable is accomplished by the use of a five-position dipswitch and overcurrent signals are pulled up to the input voltage through 10KΩ resistors. Both enable and overcurrent signals are available at a 10 position in line SIP for easy scope probe access. The demo kit utilizes an external NMOS switch in a low dropout linear regulator for pre-regulating a rough DC voltage, such as a filament voltage, to provide the 5.5V input to the four 5V linear regulators.

This kit can also provide a valid means of evaluating the UCC39811 in a typical application circuit. The UCC39811 is intended to perform the same tasks as the UCC3981 with the exception of providing the gate drive and control circuitry for the 5.5V preregulator. The preregulator function can be bypassed by providing 5.5V externally at VREG, removing Q1 and replacing C09 with a 0.1μF ceramic capacitor. In this case VFIL and VHUB should also be connected to the 5.5V supply providing DC bias for the 3.3V regulator and the gate drive for the internal 5V regulators.

TESTING PROCEDURE

1. Set all enable switches to the “off” position. SW1 switches 1-4 correspond to outputs ENA-D respectively. Switch 5 controls ENHUB.
2. Supply a minimum of 6V, maximum of 9V, from a 2A minimum supply to the V_{FIL} banana jack. Apply a 5V, 500mA supply to the V_{HUB} banana jack. Connect grounds for both supplies to the demonstration kit ground. Ensure the maximum voltage of 9V is not exceeded on either the V_{FIL} or V_{HUB} pins.
3. Connect a voltmeter to the VREG output. The voltage should read approximately 5.5V.
4. Connect the voltmeter to the V5A output. The output voltage should read approximately 0V.
5. Set the enable switch (ENA) for V5A to the “on” position. The output voltage should read approximately 5V. The corresponding enable pin of the 10 position SIP should transition from a low to a high.
6. Repeat steps 4 and 5 for outputs V5B – V5D and the 3.3V output.
7. Apply variable resistive loads to all outputs. Increase the loads sequentially to approximately 500mA on the 5V outputs, and 100mA on the 3.3V output. The appropriate overcurrent flags on the 10 position SIP should transition from a high to a low as each output reaches its overcurrent condition. Reset each load to its nominal value after observing each output’s overcurrent flag to prevent thermal problems with the device. The overcurrent flags would normally signal the USB controller of the overcurrent condition and the controller would shut down the appropriate output in an actual application. The overcurrent flags should return to a logic high once the load is reset to its nominal value.
8. Reset the enable switch for each output. The corresponding output voltages should read approximately 0V.
9. Power down the input supplies.

If the testing procedure is successfully completed the demonstration kit is verified to be functional and is ready for more rigorous and application specific evaluation to be performed.

For more complete information, pin descriptions and specifications for the UCC3981 USB power controller IC, please refer to the UCC3981 data sheet or contact your Unitrode Field Applications Engineer.

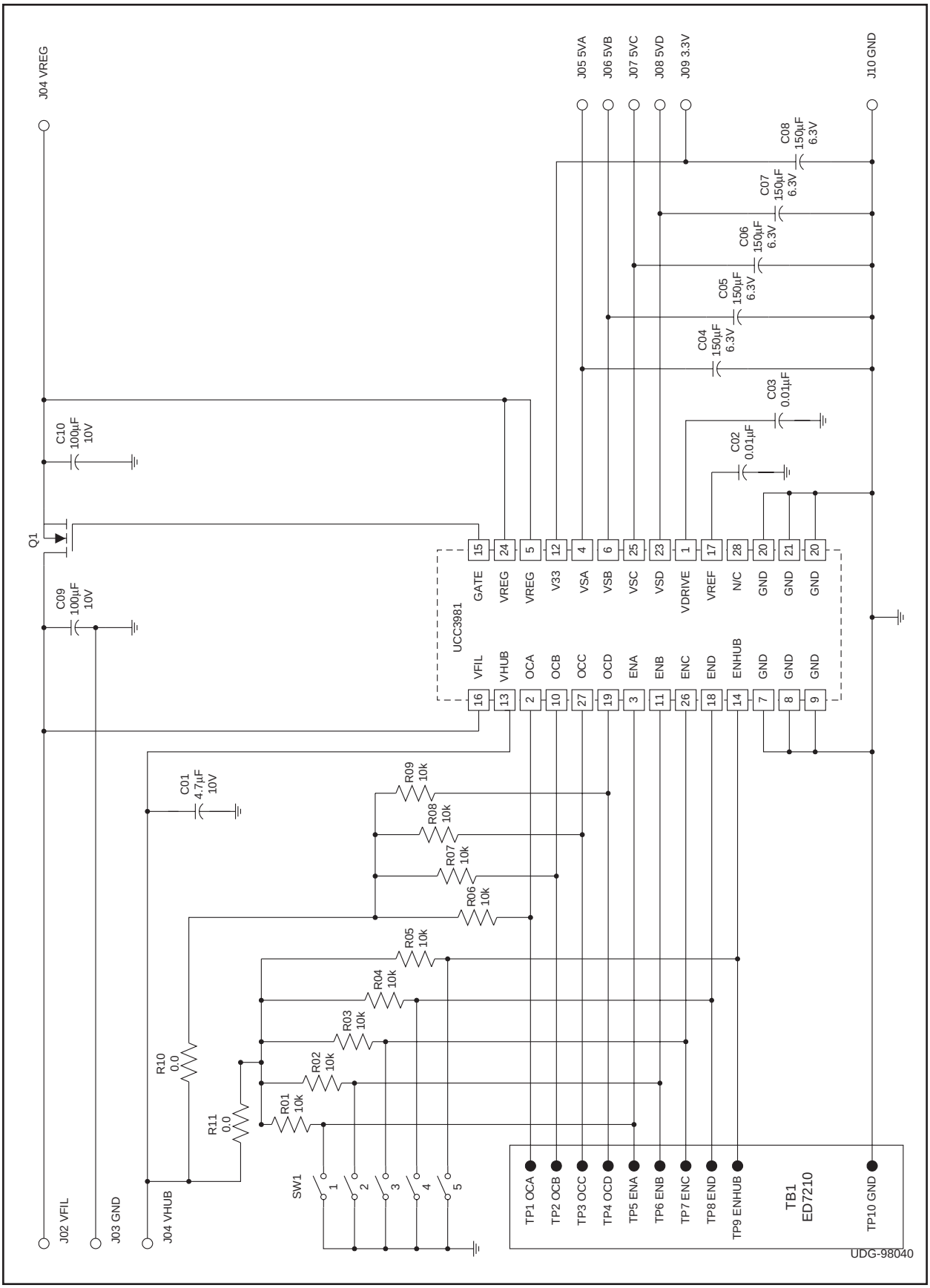

Figure 1. UCC3981 evaluation board schematic.

Notes:

1) *Absolute Maximum voltage for VHUB is 9.0V*
2) *Absolute Maximum voltage for VFIL is 9.0V*
3) *VHUB and VFIL can be connected together*
4) *Pregulator can be bypassed by providing 5.5V at VREG and VFIL, removing Q1 and replacing C09 with a 0.1 F Ceramic capacitor.*
5) *ENABLE and OVERCURRENT signals are pulled up to VHUB. 0 jumpers R10 and R11 can be removed to wire pullups to a different voltage*
6) *Capacitors C04 through C10 can be replaced with size "D" Tantalum SMD capacitors.*
7) *Capacitor C01 can be replaced with size "B" Tantalum SMD capacitors.*

Reference Designator	Description	Manufacturer	Part Number
R01–R09	10k, 5%, 1/8W, Metal Film Resistor		
R10, R11	0.0W, 5%, Jumper, Metal Film Resistor		
TB1	Pin Header, 10 position	Mill-Max	ED7210
SW1	DIP Switch, 5 Position, SPST	AMP	A5205
C01	4.7µF, 10V, Tantalum Capacitor		
C02, C03	0.01µF, Z5U, Ceramic Capacitor		
C04–C08	150µF, 6.3V, Electrolytic Capacitor		
C09, C10	100µF, 10V, Electrolytic Capacitor		
J01–J10	Binding Post		
U1	USB Power Controller IC	Unitrode	UCC3981
Q1	60V, 17A, N-Channel MOSFET	International Rectifier	IRFZ24

Table 1. UCC3981 evaluation board list of materials.

Note: UCC3981 is also the UCC3831. UCC39811 was formerly UCC38531.

UNITRODE CORPORATION
7 CONTINENTAL BLVD. • MERRIMACK, NH 03054
TEL. (603) 424-2410 • FAX (603) 424-3460

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.