

## LTC3816EUHF

# HIGH EFFICIENCY SINGLE PHASE BUCK CONVERTER FOR INTEL IMVP-6/IMVP-6.5 CPUs

### DESCRIPTION

Demonstration circuit 1672A is a high efficiency, single phase, synchronous buck converter for Intel IMVP-6/IMVP-6.5 CPUs. It can supply 25A maximum load current at up to 1.5V output with 4.5V to 28V input range. The demo board features the LTC®3816EUHF controller. The LTC3816 is a single-phase synchronous buck controller in a constant-frequency voltage mode architecture. The controller's leading edge modulation topology allows extremely low output voltages and supports a phase-lockable switching frequency up to 550kHz. The output voltage is programmed using a 7-bit VID code. The default VID jumpers (VID6 to VID0) are set to be 0110000 for 0.9V output. The LTC3816 features all of the IMVP-6/IMVP-6.5 requirements, including start-up to a preset boot voltage, differential remote output voltage sensing with programmable active voltage positioning, I<sub>mon</sub> output current reporting, power optimization during sleep state, and slow slew rate sleep state exit. Fault protection features include input undervoltage lockout, cycle-by-cycle current limit, output overvoltage protection, and power-good (PWRGD) and overtemperature flags. The LTC3816 supports wide input range (4.5V to 36V) with optional line feedforward compensation, temperature compensated inductor DCR or sense resistor output current monitoring. The LTC3816 can provide high efficiency, high power density and

versatile power solutions for embedded computing, mobile computers, internet devices and navigation displays. The controller is available in 38-pin thermally enhanced eTSSOP and 5mm × 7mm QFN packages.

The VRON pin (JP15) provides enable feature. To shut down the converter, one simple way is to force the VRON pin below 0.65V (JP15: OFF). Use JP19 jumper to select pulse-skipping or forced continuous mode operation. Switching frequency is pre-set at about 400kHz, and it can be easily modified from 150kHz to 550kHz. JP20~JP26 (VID0~VID7) are used to set the output voltage based on the IMVP-6/IMVP-6.5 VID code, as shown in table 2. JP1 and JP18 are used to select either IMVP6 or IMVP6.5 specification. For detailed information, please see LTC3816 data sheet and Intel IMVP-6/IMVP-6.5 specification.

**Design files for this circuit board are available. Call the LTC factory.**

**Table 1. Performance Summary (T<sub>A</sub> = 25°C)**

PARAMETER	CONDITION	VALUE
Input Voltage Range		4.5V to 28V
Output Voltage, V <sub>OUT</sub>	V <sub>IN</sub> = 4.5-28V, I <sub>OUT</sub> = 0A to 23A, VID6-0=0110000	0.9V ±1.5%
Maximum Output Current, I <sub>OUT</sub>	V <sub>IN</sub> = 4.5-28V, V <sub>OUTMAX</sub> = 1.5V	25A
Typical Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 1.5V, I <sub>OUT</sub> = 23A	86.7%
Typical Switching Frequency		400kHz

**Table 2. IMVP-6/IMVP-6.5 VID Output Voltage Programming**

VID6	VID5	VID4	VID3	VID2	VID1	VID0	V <sub>CC(CORE)</sub>
0	0	0	0	0	0	0	1.5000
0	0	0	0	0	0	1	1.4875
0	0	0	0	0	1	0	1.4750
0	0	0	0	0	1	1	1.4625
0	0	0	0	1	0	0	1.4500
0	0	0	0	1	0	1	1.4375
0	0	0	0	1	1	0	1.4250
0	0	0	0	1	1	1	1.4125
0	0	0	1	0	0	0	1.4000
0	0	0	1	0	0	1	1.3875
0	0	0	1	0	1	0	1.3750
0	0	0	1	0	1	1	1.3625
0	0	0	1	1	0	0	1.3500
0	0	0	1	1	0	1	1.3375
0	0	0	1	1	1	0	1.3250
0	0	0	1	1	1	1	1.3125
0	0	1	0	0	0	0	1.3000
0	0	1	0	0	0	1	1.2875
0	0	1	0	0	1	0	1.2750
0	0	1	0	0	1	1	1.2625
0	0	1	0	1	0	0	1.2500
0	0	1	0	1	0	1	1.2375
0	0	1	0	1	1	0	1.2250
0	0	1	0	1	1	1	1.2125
0	0	1	1	0	0	0	1.2000
0	0	1	1	0	0	1	1.1875
0	0	1	1	0	1	0	1.1750
0	0	1	1	0	1	1	1.1625
0	0	1	1	1	0	0	1.1500
0	0	1	1	1	0	1	1.1375
0	0	1	1	1	1	0	1.1250
0	0	1	1	1	1	1	1.1125
0	1	0	0	0	0	0	1.1000
0	1	0	0	0	0	1	1.0875
0	1	0	0	0	1	0	1.0750
0	1	0	0	0	1	1	1.0625
0	1	0	0	1	0	0	1.0500
0	1	0	0	1	0	1	1.0375
0	1	0	0	1	1	0	1.0250
0	1	0	0	1	1	1	1.0125
0	1	0	1	0	0	0	1.0000
0	1	0	1	0	0	1	0.9875
0	1	0	1	0	1	0	0.9750
0	1	0	1	0	1	1	0.9625
0	1	0	1	1	0	0	0.9500
0	1	0	1	1	0	1	0.9375
0	1	0	1	1	1	0	0.9250
0	1	0	1	1	1	1	0.9125
0	1	1	0	0	0	0	0.9000
0	1	1	0	0	0	1	0.8875
0	1	1	0	0	1	0	0.8750
0	1	1	0	0	1	1	0.8625
0	1	1	0	1	0	0	0.8500
0	1	1	0	1	0	1	0.8375
0	1	1	0	1	1	0	0.8250
0	1	1	0	1	1	1	0.8125
0	1	1	1	0	0	0	0.8000
0	1	1	1	0	0	1	0.7875
0	1	1	1	0	1	0	0.7750
0	1	1	1	0	1	1	0.7625
0	1	1	1	1	0	0	0.7500
0	1	1	1	1	0	1	0.7375
0	1	1	1	1	1	0	0.7250
0	1	1	1	1	1	1	0.7125

VID6	VID5	VID4	VID3	VID2	VID1	VID0	V <sub>CC(CORE)</sub>
1	0	0	0	0	0	0	0.7000
1	0	0	0	0	0	1	0.6875
1	0	0	0	0	1	0	0.6750
1	0	0	0	0	1	1	0.6625
1	0	0	0	1	0	0	0.6500
1	0	0	0	1	0	1	0.6375
1	0	0	0	1	1	0	0.6250
1	0	0	0	1	1	1	0.6125
1	0	0	1	0	0	0	0.6000
1	0	0	1	0	0	1	0.5875
1	0	0	1	0	1	0	0.5750
1	0	0	1	0	1	1	0.5625
1	0	0	1	1	0	0	0.5500
1	0	0	1	1	0	1	0.5375
1	0	0	1	1	1	0	0.5250
1	0	0	1	1	1	1	0.5125
1	0	1	0	0	0	0	0.5000
1	0	1	0	0	0	1	0.4875
1	0	1	0	0	1	0	0.4750
1	0	1	0	0	1	1	0.4625
1	0	1	0	1	0	0	0.4500
1	0	1	0	1	0	1	0.4375
1	0	1	0	1	1	0	0.4250
1	0	1	0	1	1	1	0.4125
1	0	1	1	0	0	0	0.4000
1	0	1	1	0	0	1	0.3875
1	0	1	1	0	1	0	0.3750
1	0	1	1	0	1	1	0.3625
1	0	1	1	1	0	0	0.3500
1	0	1	1	1	0	1	0.3375
1	0	1	1	1	1	0	0.3250
1	0	1	1	1	1	1	0.3125
1	1	0	0	0	0	0	0.3000
1	1	0	0	0	0	1	0.2875
1	1	0	0	0	1	0	0.2750
1	1	0	0	0	1	1	0.2625
1	1	0	0	1	0	0	0.2500
1	1	0	0	1	0	1	0.2375
1	1	0	0	1	1	0	0.2250
1	1	0	0	1	1	1	0.2125
1	1	0	1	0	0	0	0.2000
1	1	0	1	0	0	1	0.1875
1	1	0	1	0	1	0	0.1750
1	1	0	1	0	1	1	0.1625
1	1	0	1	1	0	0	0.1500
1	1	0	1	1	0	1	0.1375
1	1	0	1	1	1	0	0.1250
1	1	0	1	1	1	1	0.1125
1	1	1	0	0	0	0	0.1000
1	1	1	0	0	0	1	0.0875
1	1	1	0	0	1	0	0.0750
1	1	1	0	0	1	1	0.0625
1	1	1	0	1	0	0	0.0500
1	1	1	0	1	0	1	0.0375
1	1	1	0	1	1	0	0.0250
1	1	1	0	1	1	1	0.0125
1	1	1	1	0	0	0	0.0000
1	1	1	1	0	0	1	0.0000
1	1	1	1	0	1	0	0.0000
1	1	1	1	0	1	1	0.0000
1	1	1	1	1	0	0	0.0000
1	1	1	1	1	0	1	0.0000
1	1	1	1	1	1	0	0.0000
1	1	1	1	1	1	1	0.0000

## QUICK START PROCEDURE

Demonstration circuit 1672A is easy to set up to evaluate the performance of the LTC3816EUHF. Refer to Figure 1 for the proper measurement equipment setup and jumpers' location, and follow the procedure below:

1. With power off, connect the input power supply to  $V_{in}$  (4.5V-28V) and GND (input return).
2. Set VID jumpers VID6-0: 0110000 for 0.9V output.
3. Connect the output load between  $V_{out}$  and GND (Initial load: no load).
4. Connect the DVMs to the input and outputs.
5. Turn on the input power supply and check for the proper output voltages.  $V_{out}$  should be within 0.885 V to 0.915V.
6. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage and other parameters.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead and the probe tip needs to touch the (+) lead.

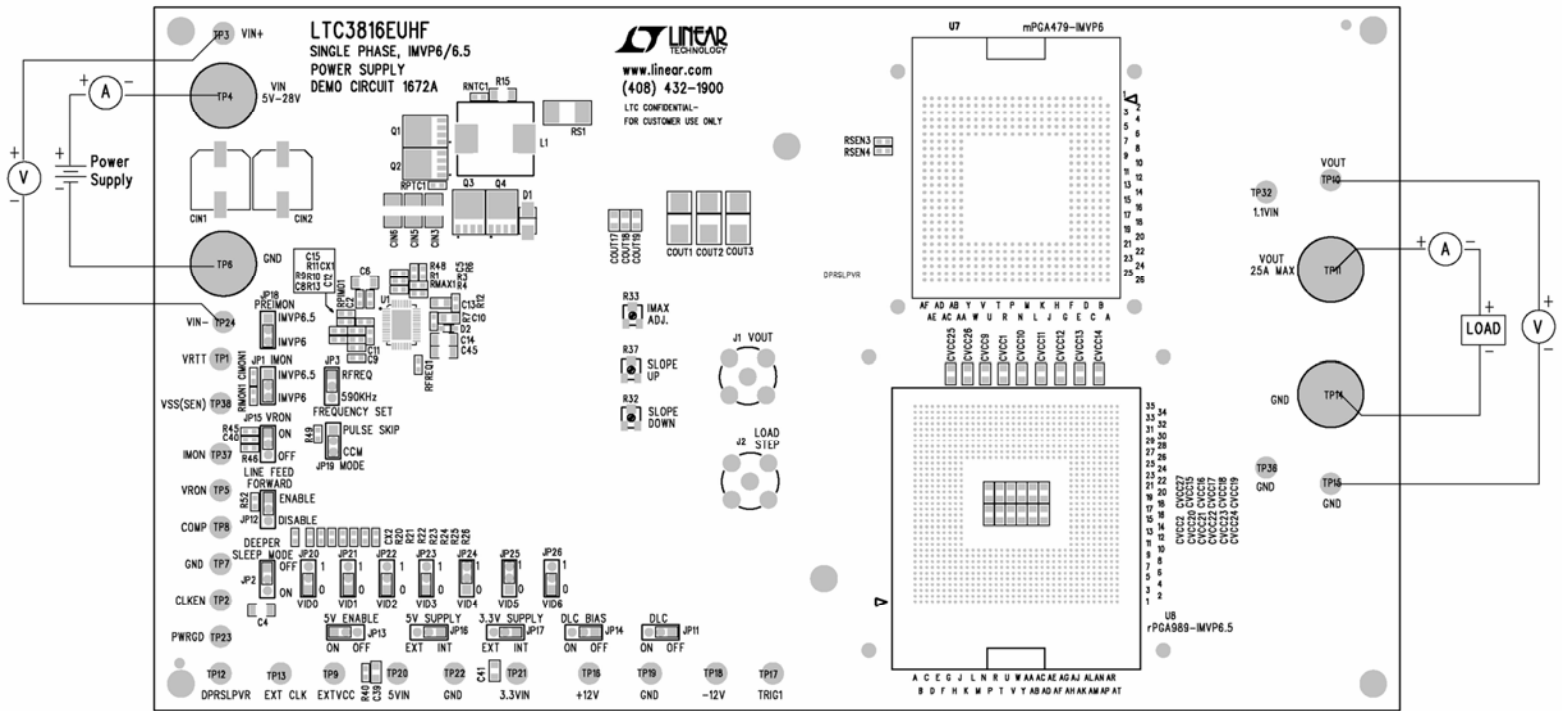


Figure 1. Proper Measurement Equipment Setup

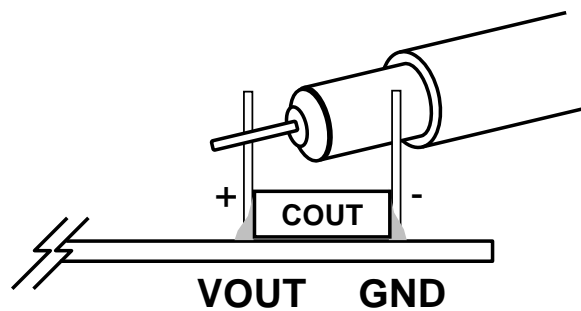


Figure 2. Measuring Output Voltage Ripple

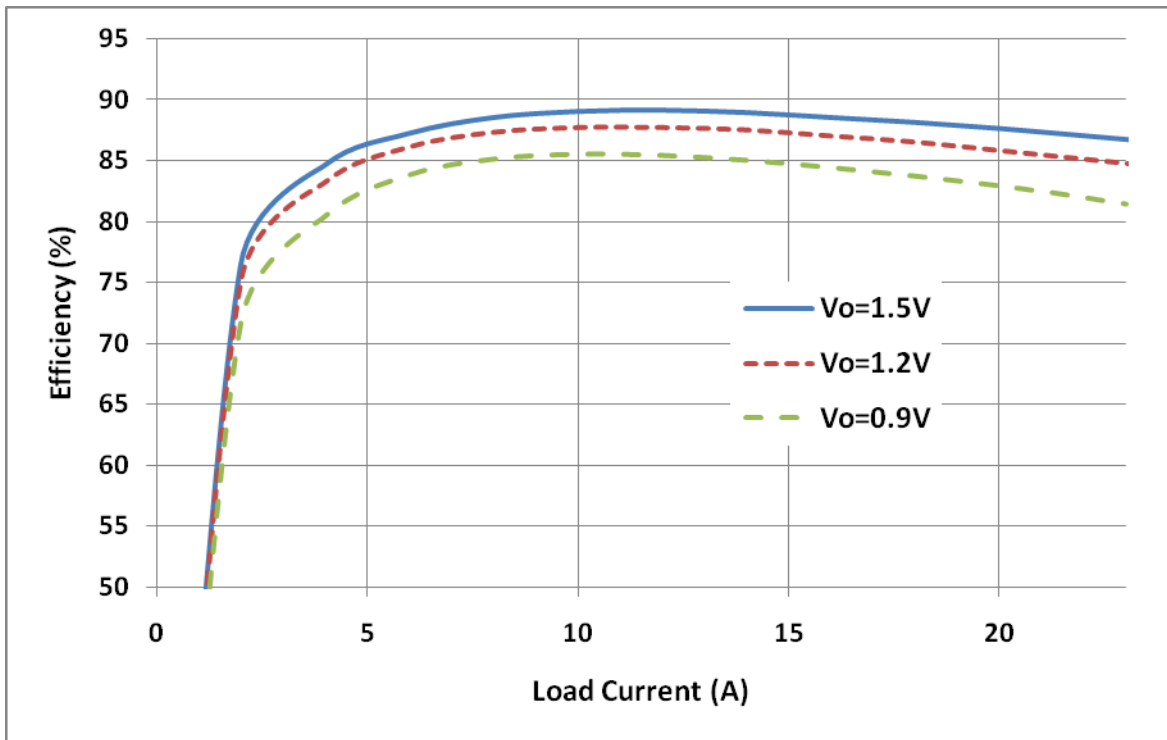
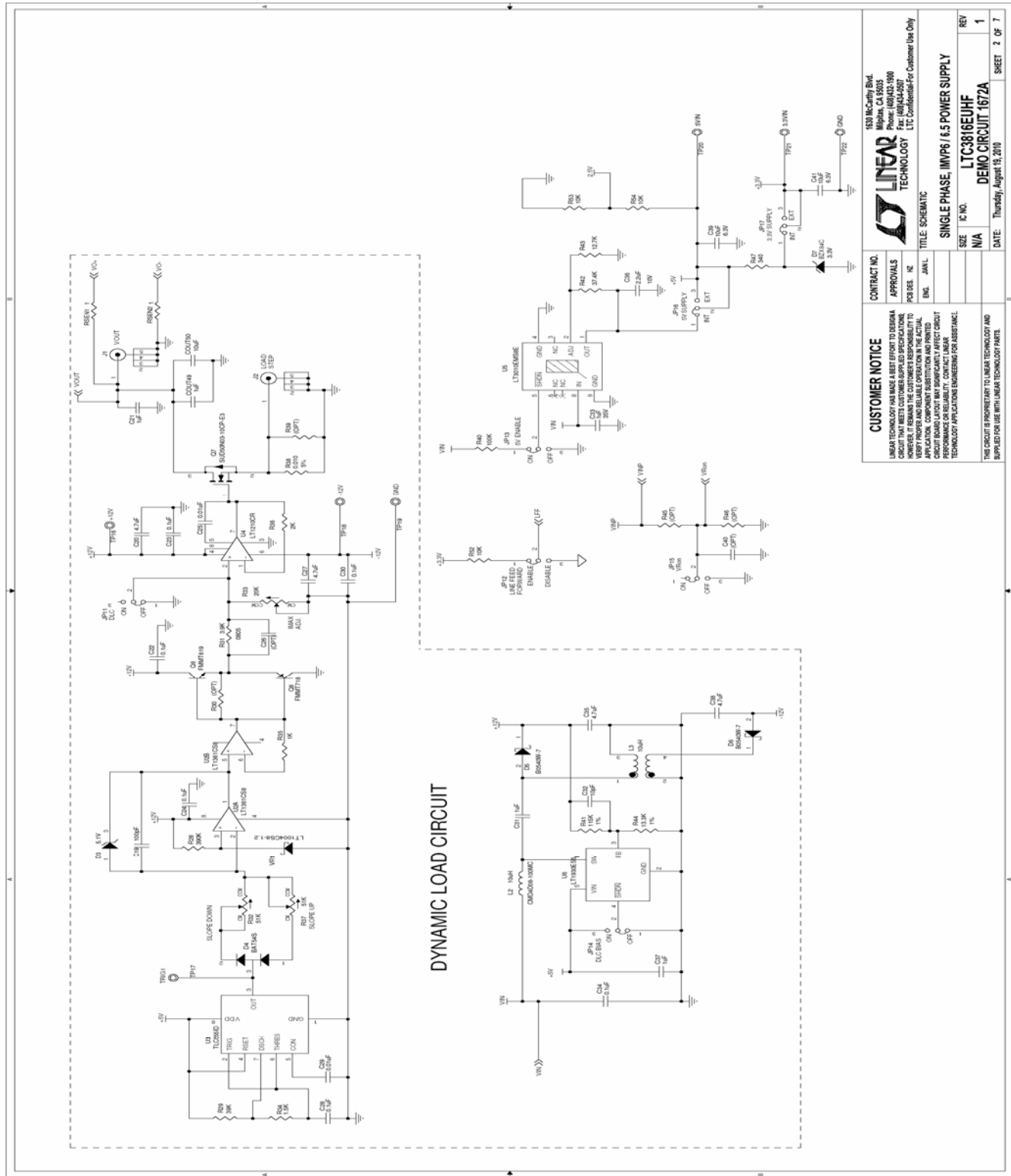


Figure 3. Efficiency vs load current





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		DATE: [REDACTED]	
		TITLE: SCHEMATIC	
		SHEET 2 OF 7	
		REV 1	
		LTC3816EUHF	
		DEMO CIRCUIT 1672A	
		DATE: Thursday, August 19, 2010	
		SHEET 2 OF 7	

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**LINEAR TECHNOLOGY**

**SINGLE PHASE, IIMPP6 / 6.5 POWER SUPPLY**

**LTC3816EUHF**

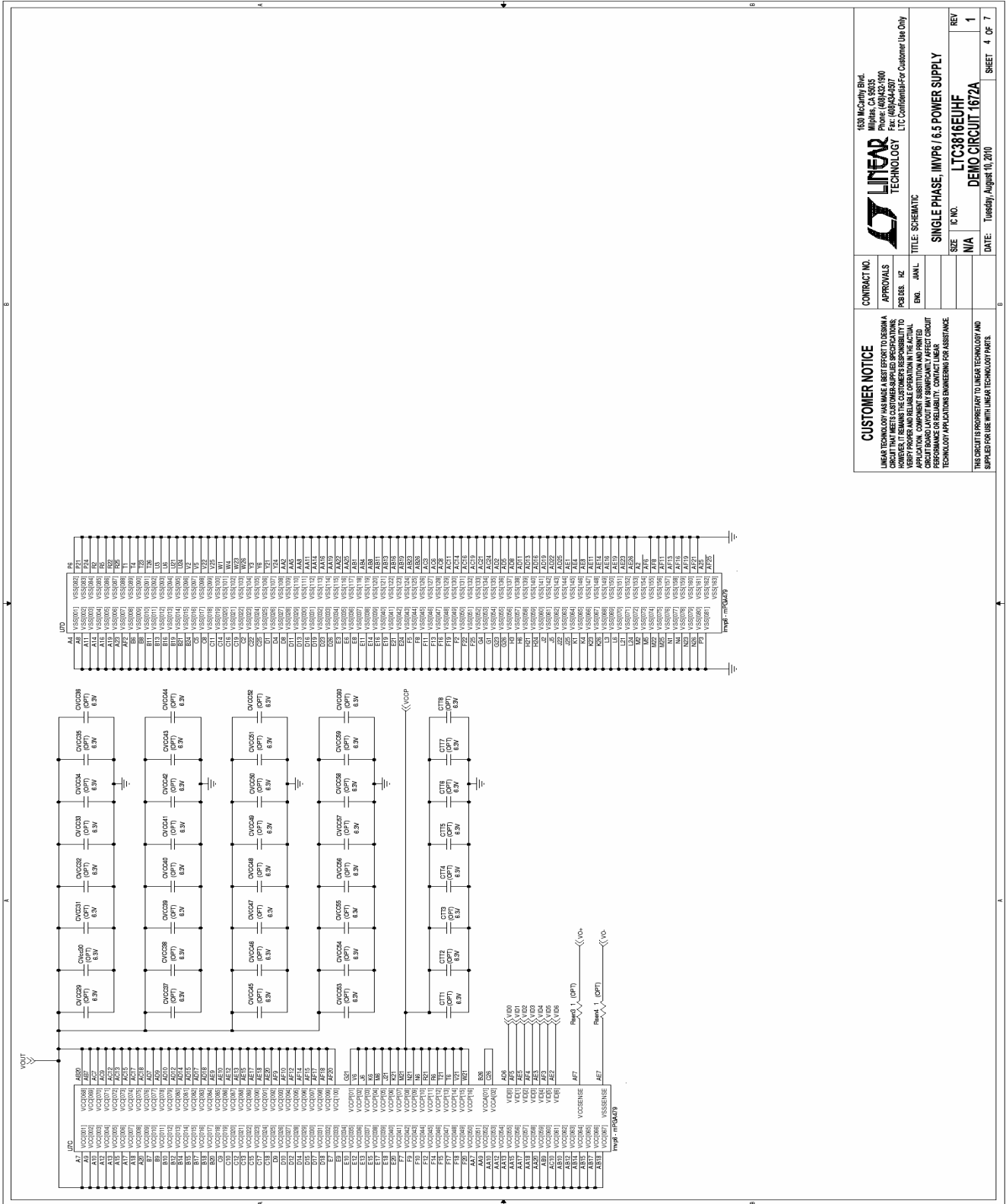
**DEMO CIRCUIT 1672A**

DATE: Thursday, August 19, 2010

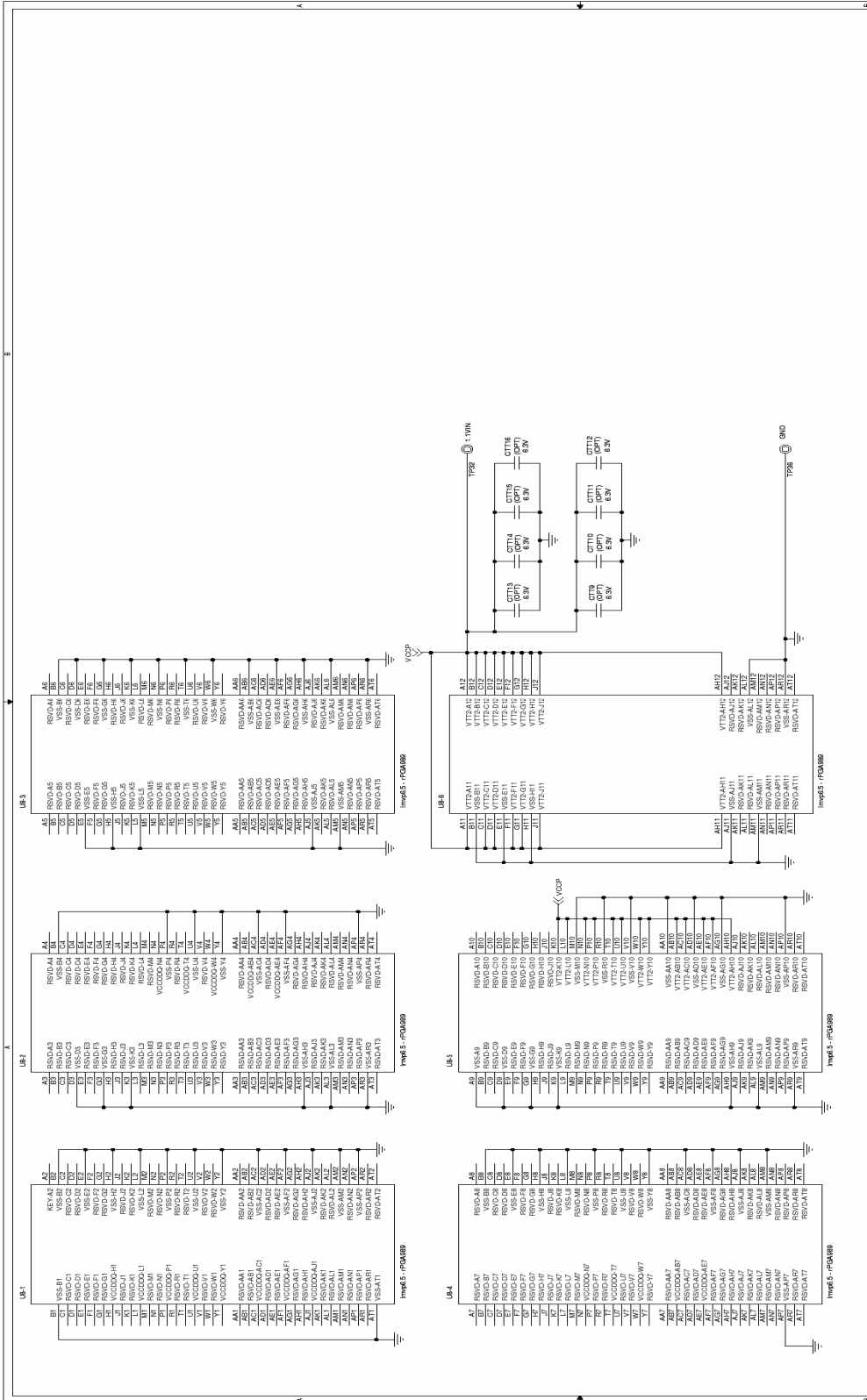
# LTC3816EUHF

<p><b>ADDR GROUP 0</b></p> <p>CONTROL</p> <p>                 A12                  A13                  A14                  A15                  A16                  A17                  A18                  A19                  A20                  A21                  A22                  A23                  A24                  A25                  A26                  A27                  A28                  A29                  A30                  A31                  A32                  A33                  A34                  A35                  A36                  A37                  A38                  A39                  A40                  A41                  A42                  A43                  A44                  A45                  A46                  A47                  A48                  A49                  A50                  A51                  A52                  A53                  A54                  A55                  A56            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  A1057                  A1058                  A1059                  A1060                  A1061                  A1062                  A1063                  A1064                  A1065                  A1066                  A1067                  A1068                  A1069                  A1070                  A1071                  A1072                  A1073                  A1074                  A1075                  A1076                  A1077                  A1078                  A1079                  A1080                  A1081                  A1082                  A1083                  A1084                  A1085                  A1086                  A1087                  A1088                  A1089                  A1090                  A1091                  A1092                  A1093                  A1094                  A1095                  A1096                  A1097                  A1098                  A1099                  A1100     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A1318                  A1319                  A1320                  A1321                  A1322                  A1323                  A1324                  A1325                  A1326                  A1327                  A1328                  A1329                  A1330                  A1331                  A1332                  A1333                  A1334                  A1335                  A1336                  A1337                  A1338                  A1339                  A1340                  A1341                  A1342                  A1343                  A1344                  A1345                  A1346                  A1347                  A1348                  A1349                  A1350                  A1351                  A1352                  A1353                  A1354                  A1355                  A1356                  A1357                  A1358                  A1359                  A1360                  A1361       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           A1449                  A1450                  A1451                  A1452                  A1453                  A1454                  A1455                  A1456                  A1457                  A1458                  A1459                  A1460                  A1461                  A1462                  A1463                  A1464                  A1465                  A1466                  A1467                  A1468                  A1469                  A1470                  A1471                  A1472                  A1473                  A1474                  A1475                  A1476                  A1477                  A1478                  A1479                  A1480                  A1481                  A1482                  A1483                  A1484                  A1485                  A1486                  A1487                  A1488                  A1489                  A1490                  A1491                  A1492                  A1493                  A1494  </p>
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# LTC3816EUHF



<b>CUSTOMER NOTICE</b>		1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (415) 964-8300 Fax: (415) 964-8807 LTC Confidential-For Customer Use Only	
LINEAR TECHNOLOGY TITLE: SCHEMATIC		SINGLE PHASE, 1MYP6 / 6.5 POWER SUPPLY LTC3816EUHF DEMO CIRCUIT 1672A	
CONTRACT NO. APPROVALS PCB LOTS: RZ P/N: JAN.L		SIZE: 1 I.C. NO.: N/A	REV: 1 SHEET: 5 OF 7
LINEAR TECHNOLOGY ASSUMES RESPONSIBILITY FOR THE DESIGN OF THIS CIRCUIT. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. THE CUSTOMER SHALL BE RESPONSIBLE FOR THE PERFORMANCE OF THE CIRCUIT. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.		DATE: Tuesday, August 10, 2010	
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.			





