

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 LTC3816EUHF 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_{mon} 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_A = 25°C)

PARAMETER	CONDITION	VALUE
Input Voltage Range		4.5V to 28V
Output Voltage, V _{OUT}	V _{IN} = 4.5-28V, I _{OUT} = 0A to 23A, VID6-0=0110000	0.9V ±1.5%
Maximum Output Current, I _{OUT}	V _{IN} = 4.5-28V, V _{OUTMAX} = 1.5V	25A
Typical Efficiency	V _{IN} = 12V, V _{OUT} = 1.5V, I _{OUT} = 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 _{CC(CORE)}
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 _{CC(CORE)}
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.

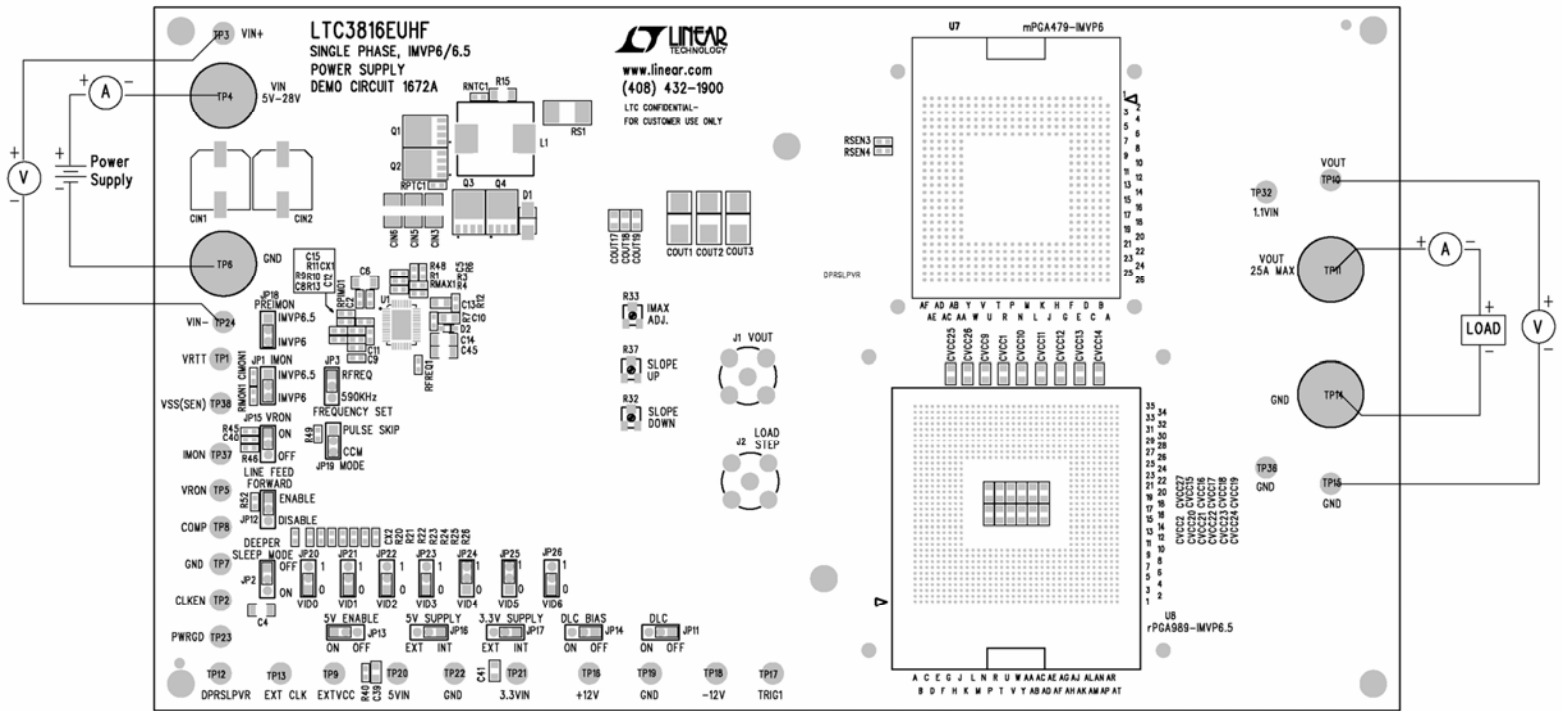


Figure 1. Proper Measurement Equipment Setup

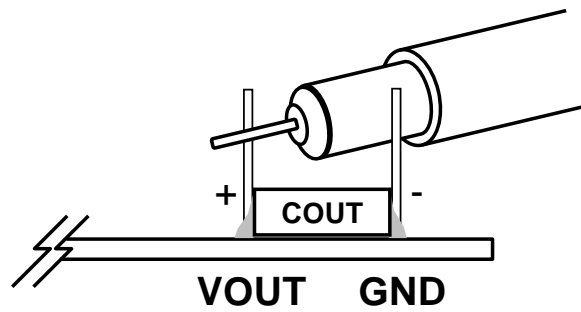


Figure 2. Measuring Output Voltage Ripple

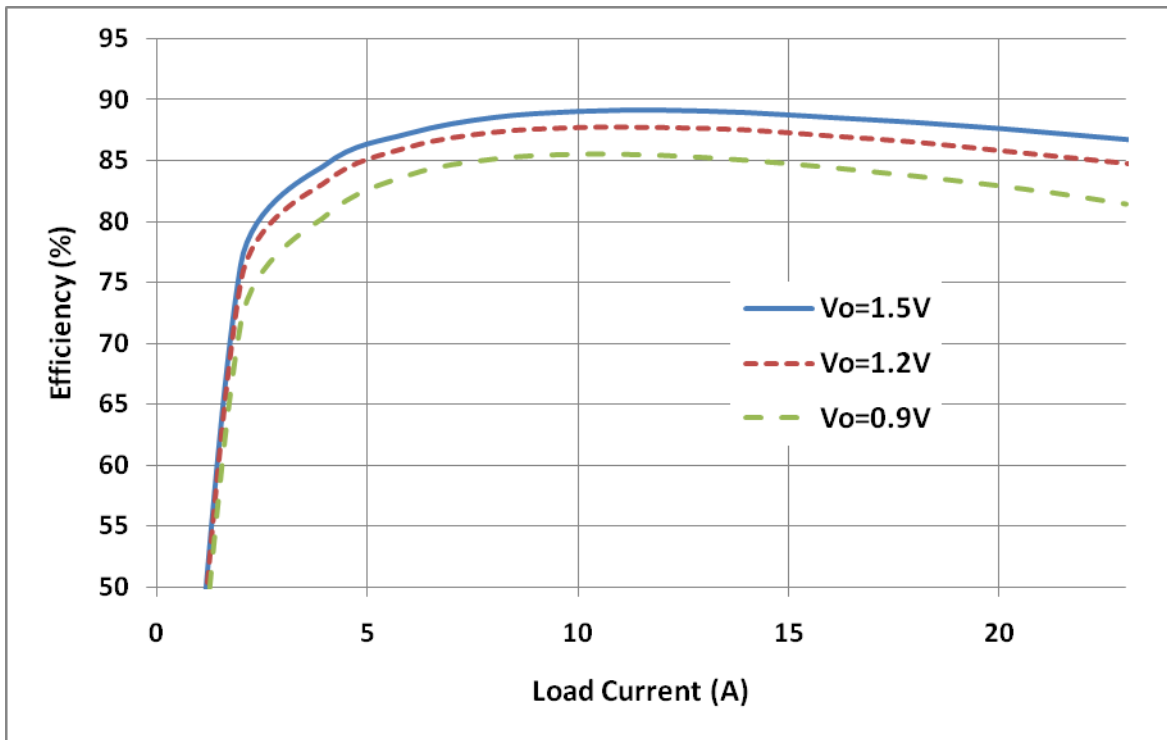
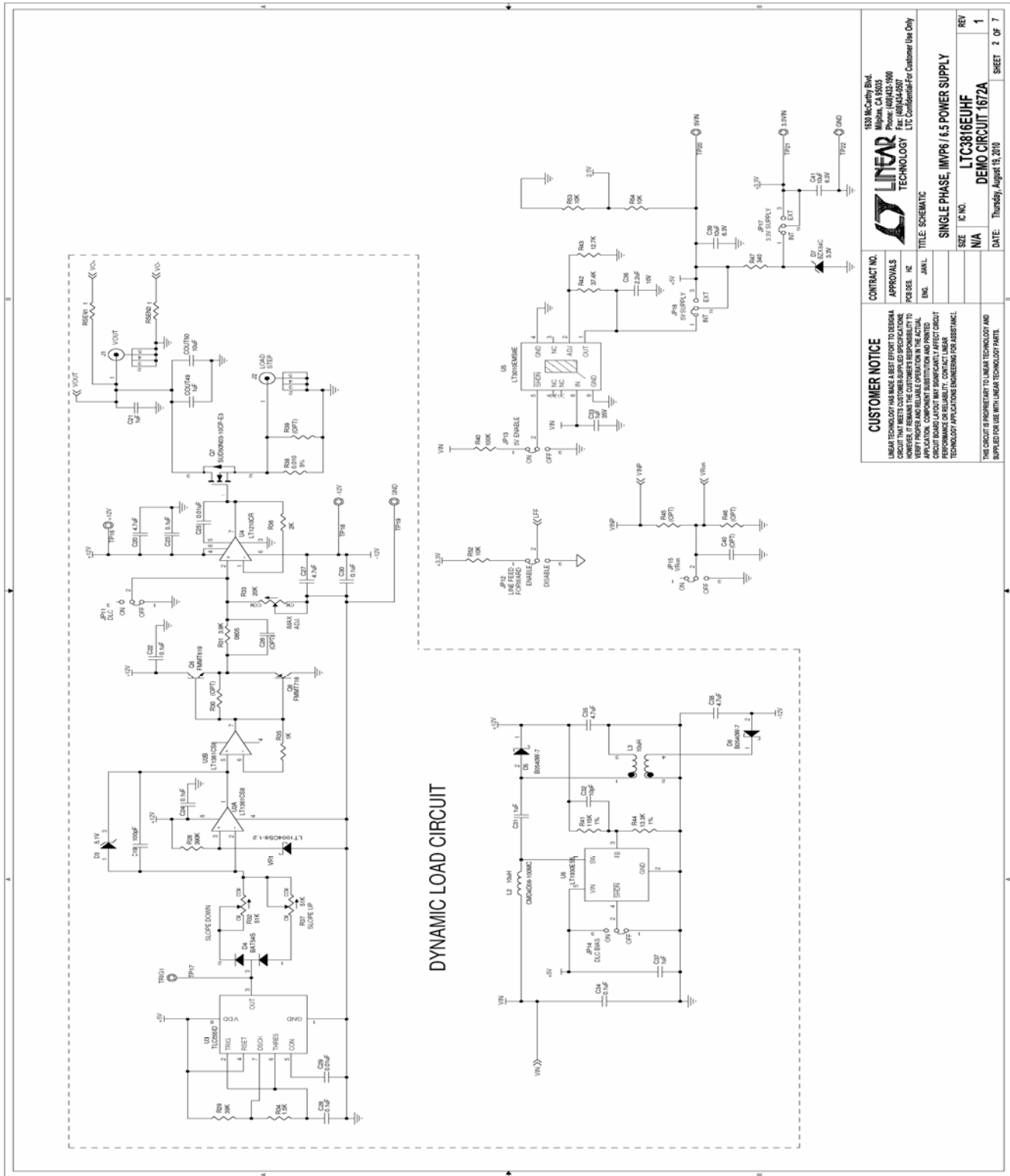


Figure 3. Efficiency vs load current

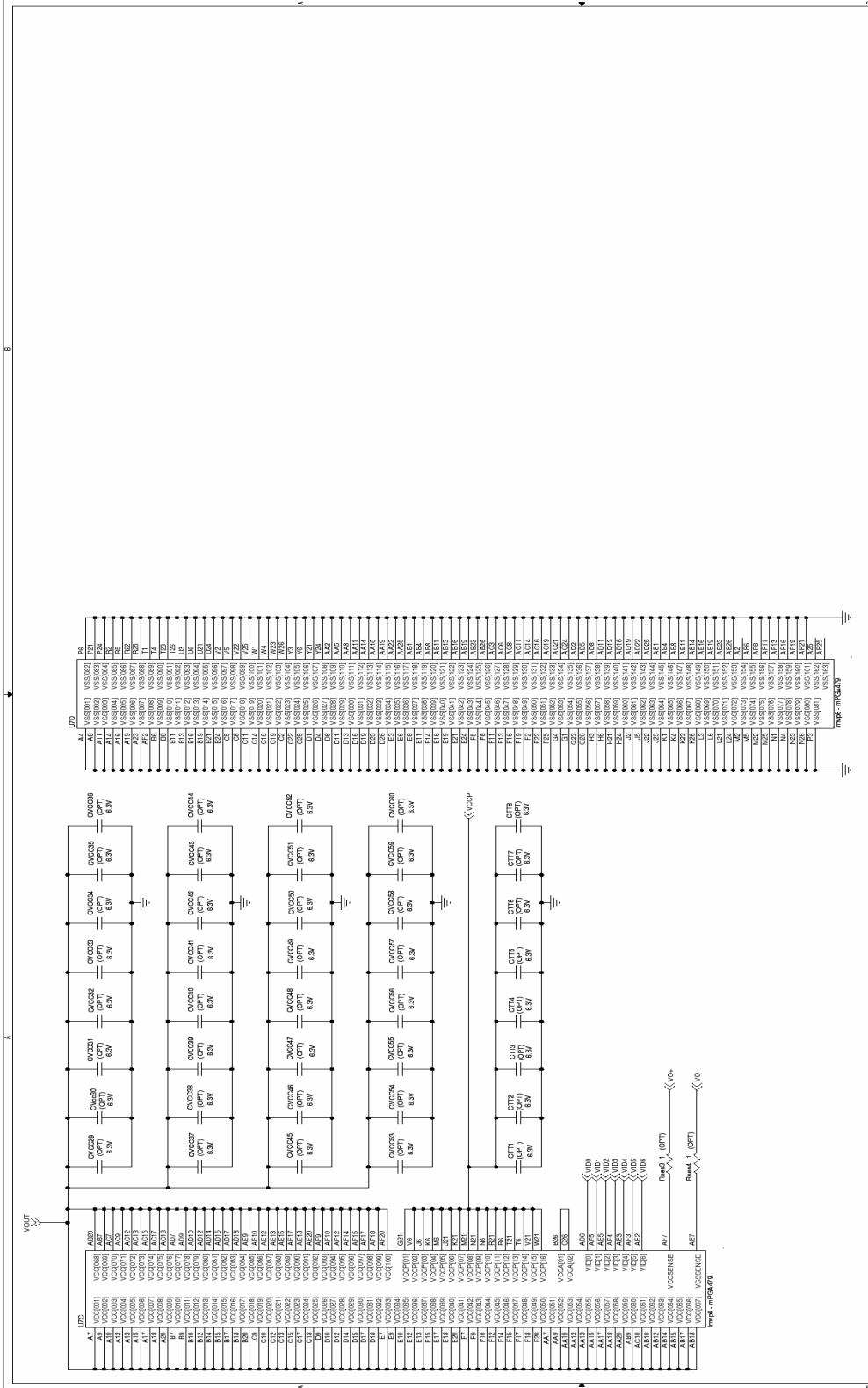


CUSTOMER NOTICE		CONTRACT NO.	
LINEAR TECHNOLOGY HAS MADE BEST EFFORT TO DESIGN THIS CIRCUIT TO MEET THE CUSTOMER'S SPECIFICATIONS. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY THE PERFORMANCE OF THE CIRCUIT IN THEIR APPLICATION. COMPONENT SUBSTITUTION AND PRINTING CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATION ENGINEERING FOR ASSISTANCE.		APPROVALS	
THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.		PDS DES. 12	
		ENCL. JAN'L	
		TITLE: SCHEMATIC	
		SINGLE PHASE, IIMPP6 / 6.5 POWER SUPPLY	
		LTC3816EUHF	
		DEMO CIRCUIT 1672A	
		DATE: Thursday, August 19, 2010	
		SHEET 2 OF 7	

LTC3816EUHF

<p>ADDR GROUP 0</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 A57 A58 A59 A60 A61 A62 A63 A64 A65 A66 A67 A68 A69 A70 A71 A72 A73 A74 A75 A76 A77 A78 A79 A80 A81 A82 A83 A84 A85 A86 A87 A88 A89 A90 A91 A92 A93 A94 A95 A96 A97 A98 A99 A100 A101 A102 A103 A104 A105 A106 A107 A108 A109 A110 A111 A112 A113 A114 A115 A116 A117 A118 A119 A120 A121 A122 A123 A124 A125 A126 A127 A128 A129 A130 A131 A132 A133 A134 A135 A136 A137 A138 A139 A140 A141 A142 A143 A144 A145 A146 A147 A148 A149 A150 A151 A152 A153 A154 A155 A156 A157 A158 A159 A160 A161 A162 A163 A164 A165 A166 A167 A168 A169 A170 A171 A172 A173 A174 A175 A176 A177 A178 A179 A180 A181 A182 A183 A184 A185 A186 A187 A188 A189 A190 A191 A192 A193 A194 A195 A196 A197 A198 A199 A200 A201 A202 A203 A204 A205 A206 A207 A208 A209 A210 A211 A212 A213 A214 A215 A216 A217 A218 A219 A220 A221 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A1018 A1019 A1020 A1021 A1022 A1023 A1024 A1025 A1026 A1027 A1028 A1029 A1030 A1031 A1032 A1033 A1034 A1035 A1036 A1037 A1038 A1039 A1040 A1041 A1042 A1043 A1044 A1045 A1046 A1047 A1048 A1049 A1050 A1051 A1052 A1053 A1054 A1055 A1056 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 A1101 A1102 A1103 A1104 A1105 A1106 A1107 A1108 A1109 A1110 A1111 A1112 A1113 A1114 A1115 A1116 A1117 A1118 A1119 A1120 A1121 A1122 A1123 A1124 A1125 A1126 A1127 A1128 A1129 A1130 A1131 A1132 A1133 A1134 A1135 A1136 A1137 A1138 A1139 A1140 A1141 A1142 A1143 A1144 A1145 A1146 A1147 A1148 A1149 A1150 A1151 A1152 A1153 A1154 A1155 A1156 A1157 A1158 A1159 A1160 A1161 A1162 A1163 A1164 A1165 A1166 A1167 A1168 A1169 A1170 A1171 A1172 A1173 A1174 A1175 A1176 A1177 A1178 A1179 A1180 A1181 A1182 A1183 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 LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A BOARD THAT WILL BE PROBABLY THE MOST RELIABLE BOARD AVAILABLE. HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. LINEAR TECHNOLOGY ASSUMES NO LIABILITY FOR PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERS FOR ASSISTANCE.

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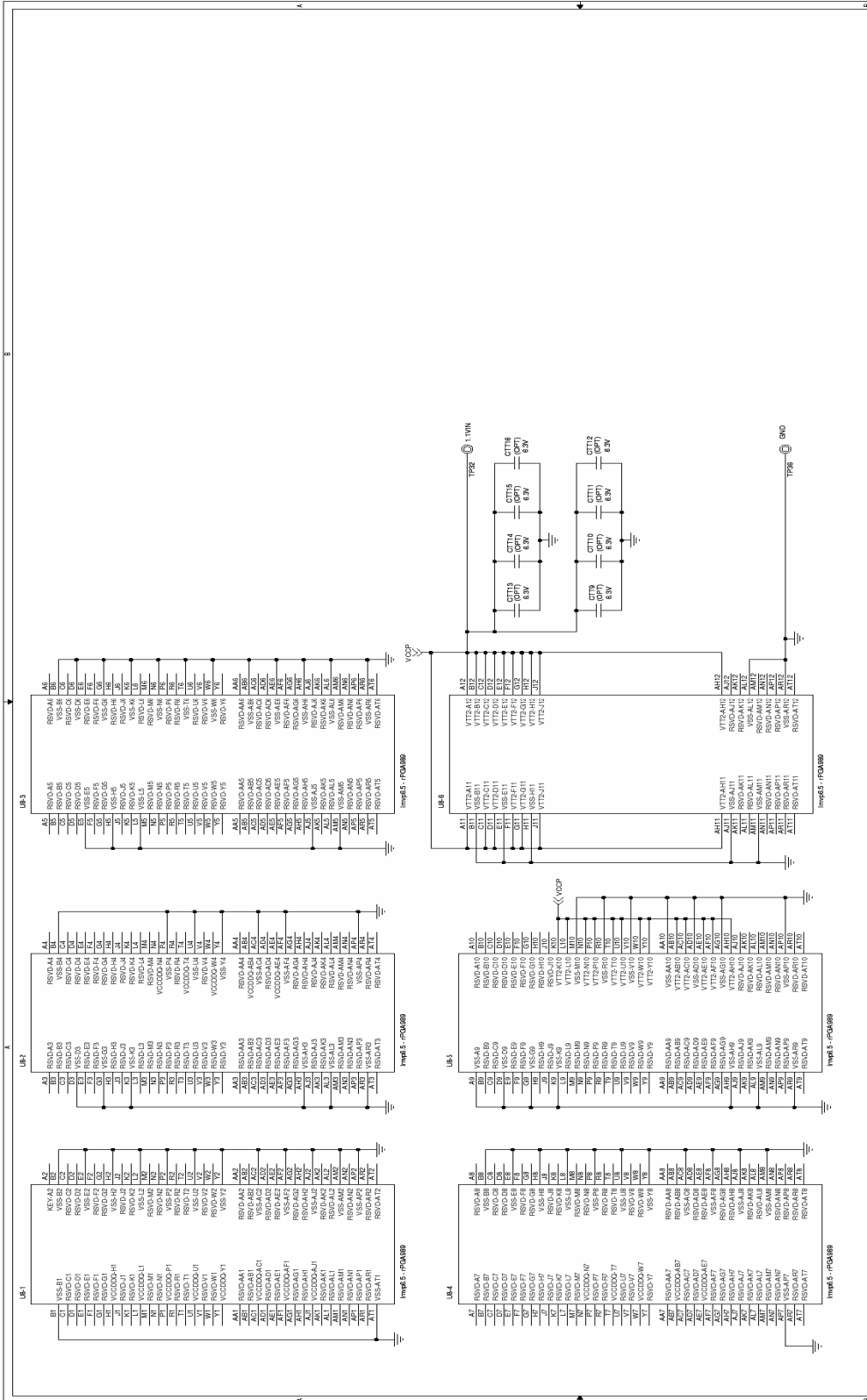
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CONTRACT NO.	APPROVALS	POB DES.	REV
	POB DES.	REV	
ENG.	JAN.		
TITLE: SCHEMATIC			
SINGLE PHASE, INVP6 / 6.5 POWER SUPPLY			
SEE	IC NO.	REV	
N/A	LTC3816EUHF	1	
DATE: Tuesday, August 10, 2010			
SHEET 4 OF 7			

1600 McCarthy Blvd.
 Milpitas, CA 95035
 Phone: (415) 964-8390
 Fax: (415) 964-8347
 E-Mail: info@linear.com
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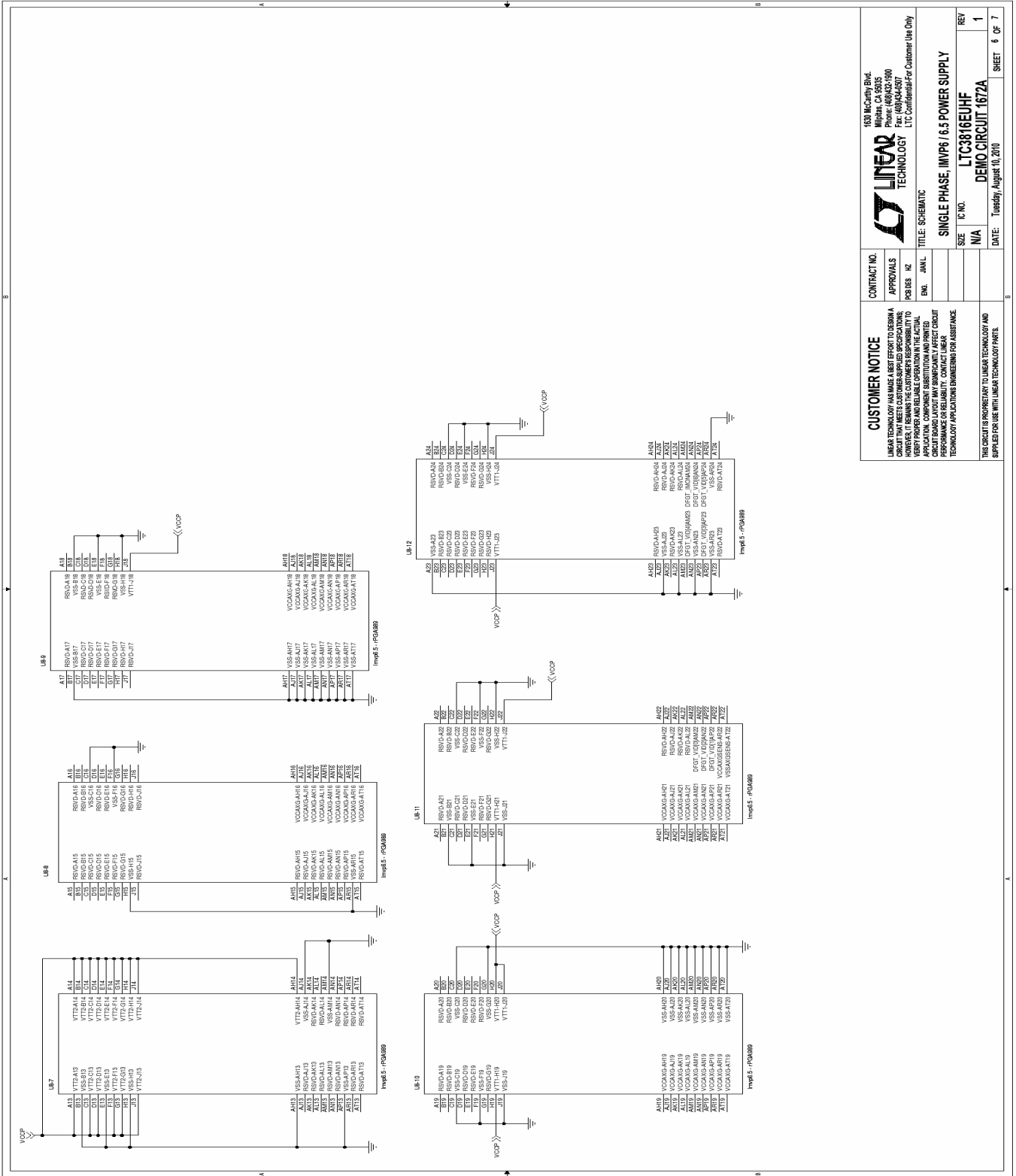
LTC3816EUHF



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SINGLE PHASE, 1MYP6 / 6.5 POWER SUPPLY LTC3816EUHF DEMO CIRCUIT 1672A		SIZE 1 Q. NO. N/A REV 1	TITLE: SCHEMATIC DATE: Tuesday, August 10, 2010 SHEET 5 OF 7



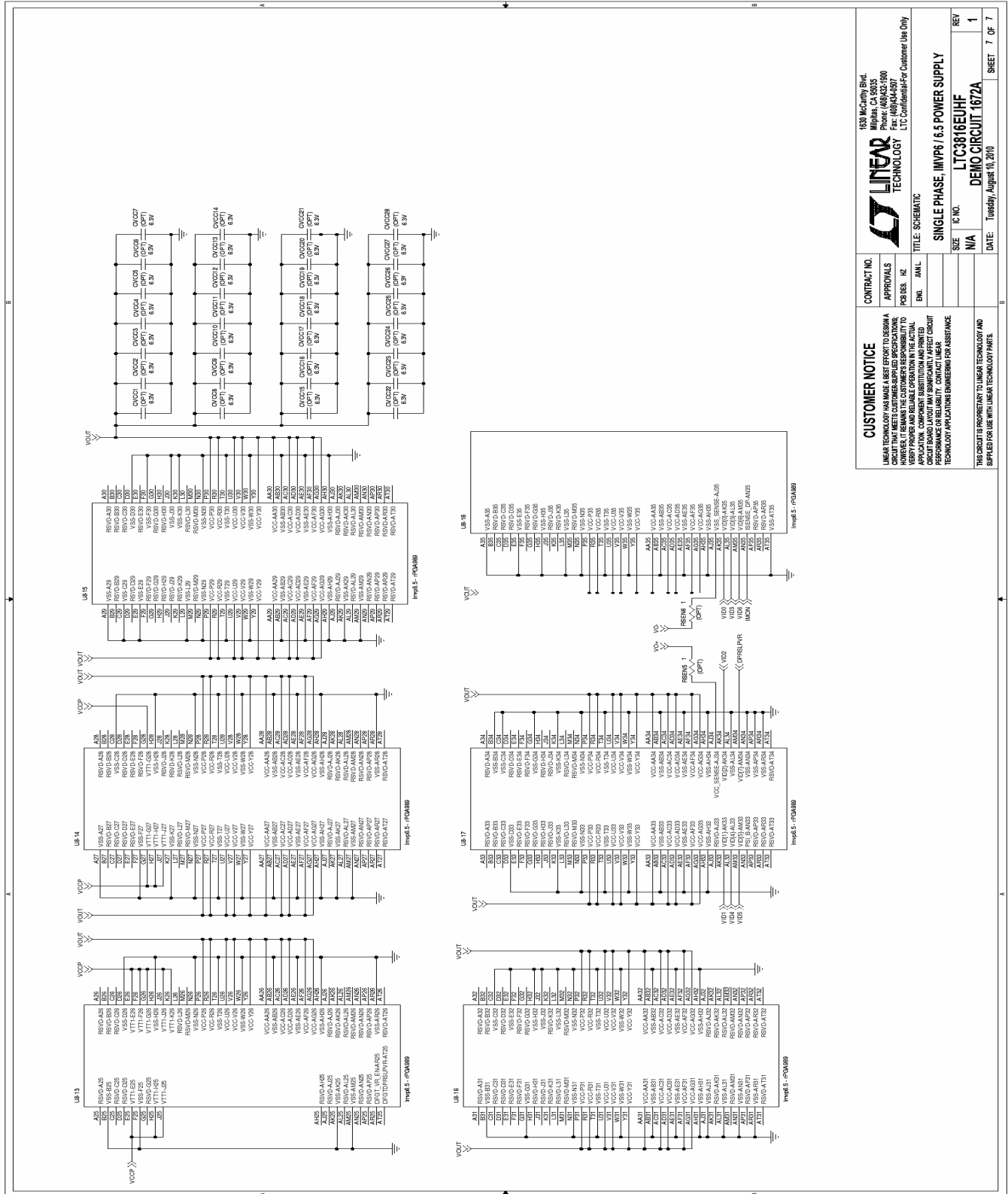
LTC3816EUHF



CUSTOMER NOTICE		CONTRACT NO.	APPROVALS
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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.		TITLE: SCHEMATIC	
		SINGLE PHASE, INVPS / 6.5 POWER SUPPLY	
		SIZE	IC NO.
		N/A	LTC3816EUHF
		DATE: Tuesday, August 10, 2010	REV
			1
			SHEET 6 OF 7

1838 McCarty Blvd.
 Milpitas, CA 95025
 Phone: (408)435-9900
 FAX: (408)435-9909
 E-MAIL: LTC_Consultant@Customers.Lin.com

LTC3816EUHF



CUSTOMER NOTICE		CONTRACT NO.	APPROVALS	PER DES.	Hz	ENG.	MANL.	TITLE: SCHEMATIC
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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.								
		IC NO.	LTC3816EUHF		REV	1		
		SIZE	N/A		DATE	Tuesday, August 10, 2010		SHEET 7 OF 7
		REV	DENO CIRCUIT 1672A					
		DATE	Tuesday, August 10, 2010					

1639 McCarty Blvd.
Milpitas, CA 95025
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LINEAR TECHNOLOGY

SINGLE PHASE, INVP6 / 6.5 POWER SUPPLY

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IC NO. LTC3816EUHF
REV 1

SIZE N/A
DATE Tuesday, August 10, 2010
SHEET 7 OF 7

CONTRACT NO.
APPROVALS
PER DES. Hz
ENG. MANL.
TITLE: SCHEMATIC

CUSTOMER NOTICE
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