Keywords: FPGA, Xilinx, power module, Kintex, 7 series, reference design, point of load regulator, power supply, POL

REFERENCE DESIGN 5448 INCLUDES: √Tested Circuit √Schematic √BOM

# Kintex-7 Series Power Module

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*Abstract: This reference design enables a complete power-supply solution for powering Xilinx® Kintex®-7 series field-programmable gate array (FPGA) using Maxim's power-supply solutions.*

This fully tested reference design provides a complete power-supply solution for powering a typical Xilinx Kintex-7 series field-programmable gate array (FPGA) using Maxim's power-supply solutions. The Kintex-7 (7K325T FPGA application) requires eight distinct power supply rails as follows:

**Design Description**

| FPGA Rail | Input Voltage | Output Voltage | Current | Maxim Solution |
|---|---|---|---|---|
| $V_{CCINT}$, $V_{CCBRAM}$ | 12V | 1V | 6A | MAX8686 |
| $V_{CCAUX}$, $V_{CCAUX\_IO}$, $V_{CCO}$, $V_{CCADC}$, MGTAVCCAUX | 12V | 1.8V | 6A | MAX8686 |
| MGTAVCC | 12V | 1V | 6A | MAX8686 |
| $V_{CC0}$ | 12V | 3.3V | 8A | MAX8686 |
| $V_{CC0}$ | 12V | 2.5V | 8A | MAX8686 |
| $V_{CC0}$ | 12V | 1.5V/1.35V | 4A | MAX8654 |
| MGTAVTT, MGTAVTTRCAL | 12V | 1.2V | 4A | MAX8654 |
| $V_{CCAUX\_IO}$ | 12V | 2V | 2A | MAX15041 |

This reference design provides the required eight power rails using five MAX8686 synchronous pulse-width modulation (PWM) step-down regulators, two MAX8654 high-efficiency switching regulators, and the MAX15041 low-cost synchronous DC-DC converter with internal switches. These devices can be sequenced at power-up, as indicated in **Figure 1**.

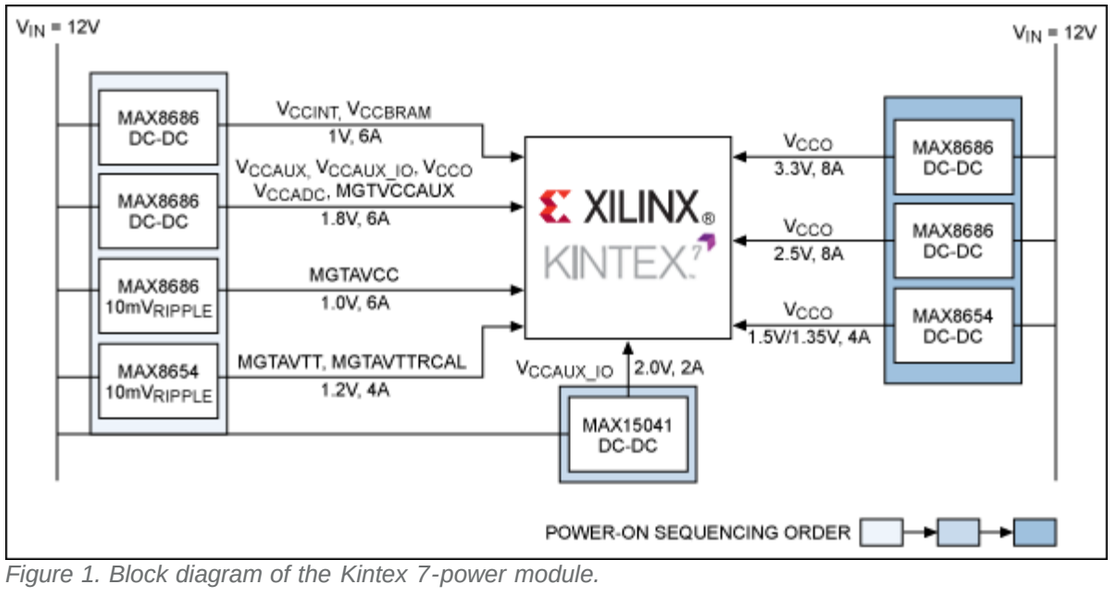
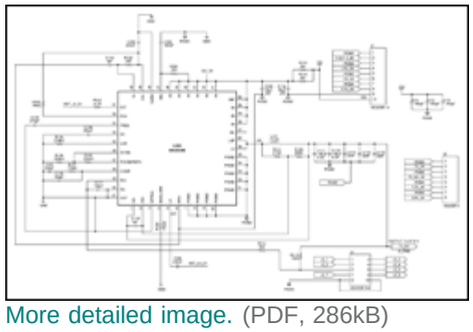



*Figure 1. Block diagram of the Kintex 7-power module.*

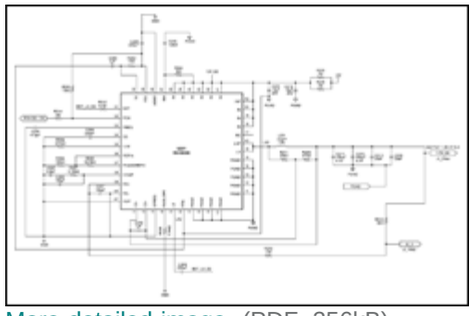
These point-of-load (POL) regulators were chosen for this design due to their accuracy, small size, and ease of use. The MAX8686 monolithic synchronous step-down converter is capable of providing up to 25A with 1% accurate internal reference voltage from a 6mm x 6mm package. The MAX8654 monolithic synchronous step-down converter can provide up to 8A with very low on-resistance internal MOSFETs. The MAX15041 monolithic synchronous step-down converter is capable of providing up to 3A from a 3mm x 3mm package.

Detailed schematics for each POL are shown below in **Figures 2** through **9**, and the complete bill of materials (BOM) is included at the end of this document. This power module can be purchased from Avnet.



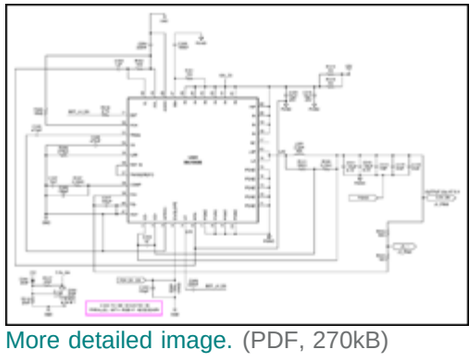
More detailed image. (PDF, 286kB)

*Figure 2. The MAX8686 is used to supply 1V/6A for $V_{CCINT}$ and $V_{CCBRAM}$.*



More detailed image. (PDF, 256kB)

*Figure 3. The MAX8686 supplies 1.8V/6A for $V_{CCAUX}$, $V_{CCAUX\_IO}$, $V_{CCO}$, $V_{CCADC}$, and MGTAVCCAUX.*



More detailed image. (PDF, 270kB)

*Figure 4. The MAX8686 is used to supply 3.3V/8A for $V_{CCO}$.*

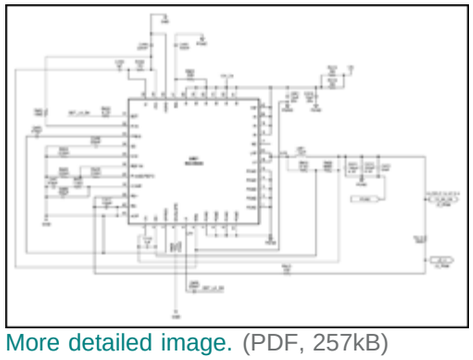


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*Figure 5. The MAX8686 supplies 1V/6A for MGTAVCC.*

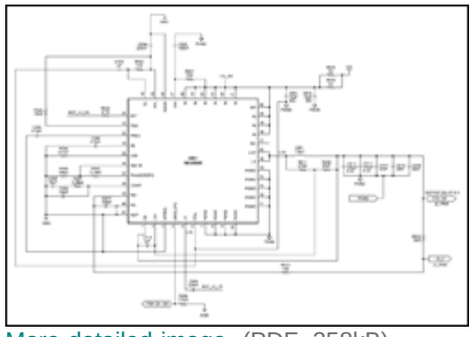

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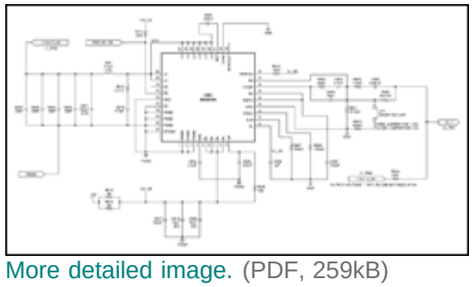
*Figure 6. The MAX8686 is used to supply 2.5V/8A for $V_{CCO}$.*



More detailed image. (PDF, 259kB)

*Figure 7. The MAX8654 is used to supply 1.5V or 1.35V at 4A for $V_{CCO}$.*

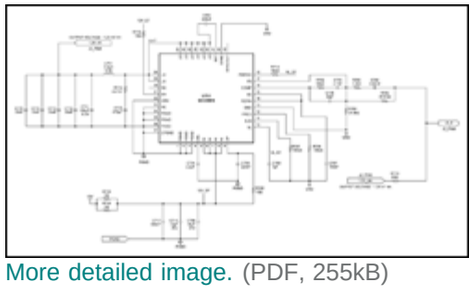


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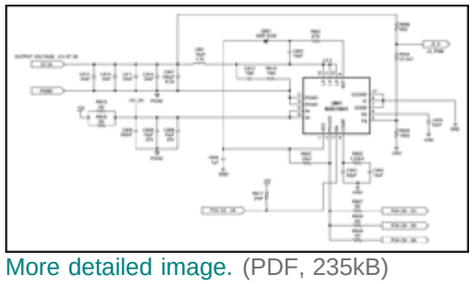
*Figure 8. The MAX8654 is used to supply 1.2V/4A for MGTAVTT and MGTAVTTRCAL.*



More detailed image. (PDF, 235kB)

*Figure 9. The MAX15041 is used to supply 2V/2A for $V_{CCAUX\_IO}$.*

**Table 1. Bill of Materials (BOM)**

| Item | Qty | Reference Designator | Description | Mfg | Part Number | Value | Footprint |
|---|---|---|---|---|---|---|---|
| 1 | 3 | C1, C2, C3 | 16V, 20% | Cornell Dubilier | AVES107M16D16T-F | 100µF | SMD 6.3mm Dia. x 5.3mm L x 6.6mm H |
| 2 | 16 | C101, C114, C201, C214, C301, C314, C401, C414, C501, C514, C606, C614, C706, C714, C806, C808 | 25V, X7R, 125°C | Murata | GRM31CR71E106MA12L | 10µF | 1206 |
| 3 | 8 | C102, C202, C302, C402, C502, C617, C717, C809 | 25V, X7R, 125°C | Murata | GRM188R71E104KA01D | 100n (0.1µF) | 0603 |
| 4 | 13 | C103, C110, C203, C210, C303, C310, C403, C410, C503, C510, C609, C709, C804 | 16V, X5R, 85°C | Murata | GRM188R61C105KA93D | 1µF | 0603 |
| | | C113, | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 8 | C213, C313, C413, C511, C613, C713, C811 | 1µF, 16V, X5R, 85°C | Murata | GRM188R61C105KA93D | DNP | 0603 |
| 6 | 8 | C105, C205, C305, C405, C505, C610, C710, C812 | 50V, B, 85°C | Murata | GRM188B11H471KA01D | 470pF | 0603 |
| 7 | 3 | C107, C207, C407 | 16V, X7R, 125°C | Vishay | VJ0603Y682KXJCW1BC | 6.8nF | 0603 |
| 8 | 13 | C111, C112, C211, C212, C311, C312, C411, C412, C512, C513, C611, C711, C807 | 6.3V, X6S, 105°C | Murata | GRM32EC80J107ME20L | 100µF | 1210 |
| 9 | 16 | C115, C116, C215, C315, C316, C515, C516, C612, C615, C616, C712, C715, C716, C810, C815, C816 | 100µF, 6.3V, X6S, 105°C | Murata | GRM32EC80J107ME20L | DNP | 1210 |
| 10 | 2 | C306, C506 | 16V, X7R, 125°C | Murata | GRM188R71C474KA88D | 470nF (0.47µF) | 0603 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | 3 | C307, C507, C802 | 16V, X7R, 125°C | Vishay | VJ0603Y153KXJCW1BC | 15nF | 0603 |
| 12 | 3 | C308, C508, (R308) | 50V, C0G, 125°C | TDK | CGA3E2C0G1H181J | 180pF | 0603 |
| 13 | 8 | C317, C417, C108, C117, C208, C217, C408, C517 | 16V, X7R, 125°C | Vishay/Vitramon | VJ0603Y101KXJCW1BC | 100pF | 0603 |
| 14 | 17 | C601, C608, C701, C708, C106, C109, C206, C209, C309, C406, C409, C509, C104, C204, C304, C404, C504 | 16V, X7R, 125°C | TDK | CGA3E2X7R1C224K | 220nF (0.22µF) | 0603 |
| 15 | 2 | C602, C702 | 16V, X7R, 125°C | AVX | 0603YC681KAT2A | 680pF (0.68nF) | 0603 |
| 16 | 2 | C603, C703 | 50V, X7R, 125°C | Vishay | VJ0603Y272KXACW1BC | 2.7nF | 0603 |
| 17 | 2 | C604, C704 | 25V, X5R, 85°C | TDK | C2012X5R1E225KT | 2.2µF | 0805 |
| 18 | 2 | C605, C705 | 50V, C0G, 125°C | Xicon | 140-CC504N390J-RC | 39pF | 0603 |
| 19 | 1 | C607 | 10V, X7R, 125C | TDK | C1608X7R1A334KT | 330nF (0.33µF) | 0603 |
| 20 | 1 | C707 | 25V, X7R, 125°C | TDK | CGA3E2X7R1E154K | 150nF | 0603 |
| 21 | 1 | C801 | 25V, X7R, 125°C | Murata | GRM188R71E103KA01D | 10nF | 0603 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | 1 | C803 | 50V, C0G, 125°C | Vishay | VJ0603A820JXACW1BC | 82pF | 0603 |
| 23 | 1 | C805 | 16V, X7R, 125°C | Murata | GRM188R71C823KA01D | 82nF (0.082µF) | 0603 |
| 24 | 1 | D301 | VDZT2R7.5B, 7.5V | ROHM | VDZT2R7.5B | DNP | VMD-2 |
| 25 | 1 | D801 | Schottky, 20V, 1A | ON | NSR0320MW2T1G | NSR0320 | SOD-323 |
| 26 | 1 | J1 | Power Header, 10-Pin | Samtec | HPM-10-05-T-S | Header 10 | TH |
| 27 | 1 | J2 | Power Header, 8-Pin | Samtec | HPM-08-05-T-S | Header 8 | TH |
| 28 | 1 | J3 | Header, 10-Pin | Samtec | FW-05-05-F-D-361-085 | Header 5X2 | SMD |
| 29 | 1 | JP1-A | JUMPER SOCKET | FCI | 65474-004LF | Shorting | 2.5mm Socket |
| 30 | 1 | JP1 | BergStik 2.5mm Header | FCI | 68000-124HLF | BergStik | TH |
| 31 | 2 | L101, L401 | 13.3A, Low DCR - 5.9 | Pulse | PG0642.152NL | 1.2µH | Custom |
| 32 | 1 | L201 | 12A, Low DCR - 5.9mΩ | Vishay/Dale | IHLP4040DZER2R2M01 | 2.2µH | Custom |
| 33 | 1 | L301 | 15A, 4.5mΩ | Coiltronics | DR125-2R2-R | 2.2µH | Custom |
| 34 | 1 | L501 | 18.3A, 2.9mΩ | Coiltronics | DR125-1R5-R | 1.5µH | Custom |
| 35 | 2 | L601, L701 | 5.2A, 20mΩ | TDK | VLP8040T-3R3N | 3.3µH | Custom |
| 36 | 1 | L801 | 3.2A, 38mΩ | TDK | VLP8040T-100M | 10µH | Custom |
| 37 | 1 | Q301 | SIA419DJ MOSFETp-CH 20V 12A | Vishay/Siliconix | | DNP | SC70-6 |
| 38 | 18 | R101, R102, R113, R201 | 1%, 0.1W, 50V, Thick | Bourns | CR0603-FX-10R0GLF | 10Ω | 0603 |
| 39 | 2 | R617, R817 | 10Ω, 1%, 0.1W, 50V | Bourns | CR0603-FX10R0GLF | DNP | 0603 |
| | | R103, | | | | | |

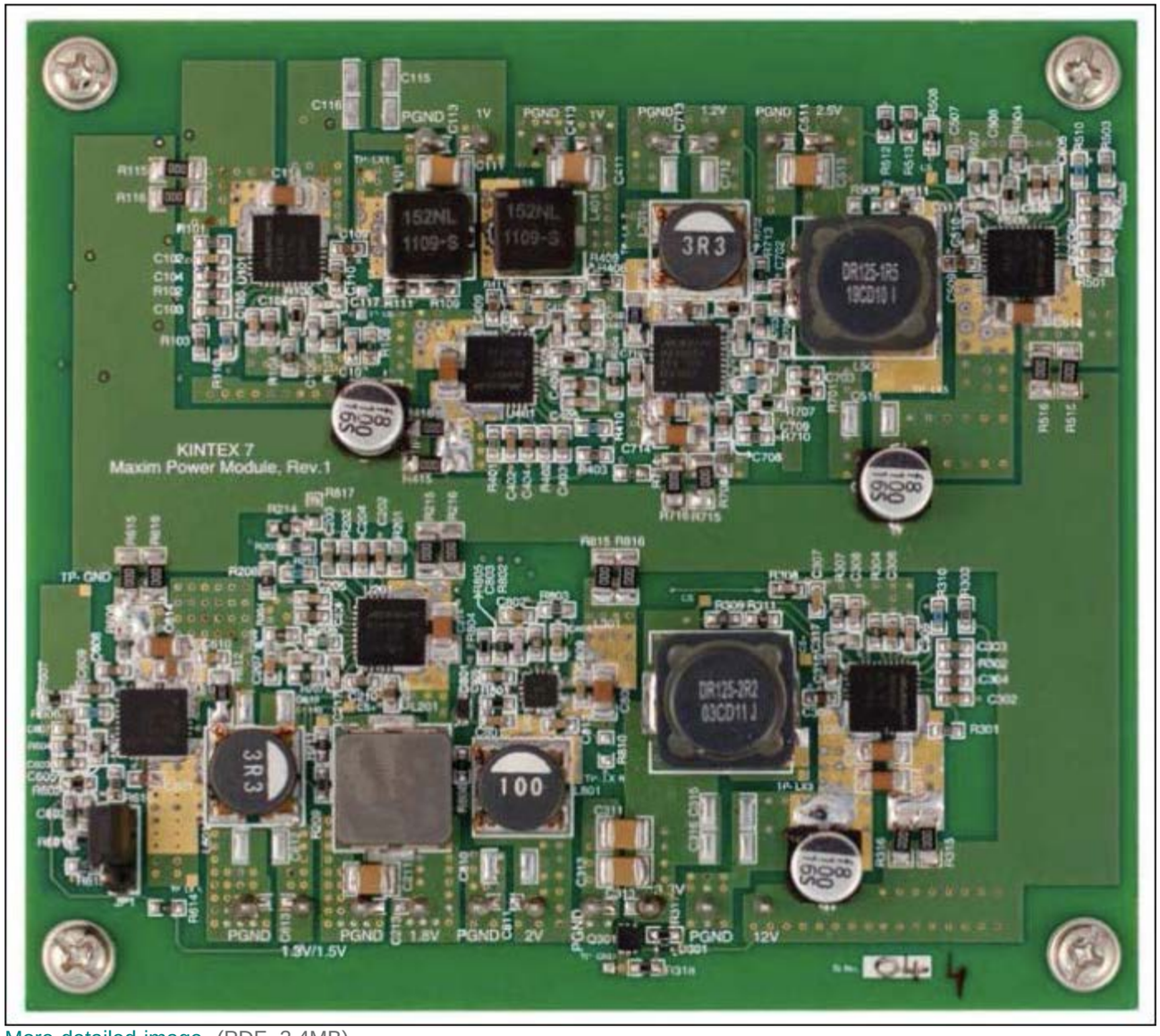
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40 | 10 | R203, R303, R403 | 1%, 0.1W, 50V, Thick | Bourns | CR0603-FX1002HLF | 10kΩ | 0603 |
| 41 | 4 | R104, R204, R304, R404 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603FX-2743ELF | 274kΩ | 0603 |
| 42 | 1 | R405 | 0.1%, 1/16W, 75V, Thin film | Susumu | RG1608P-2323-B-T5 | 232kΩ | 0603 |
| 43 | 1 | R105 | 0.1%, 1/16W, 75V | Susumu | RG1608P-2373-B-T5 | 237kΩ | 603 |
| 44 | 4 | R106, R206, R406, R506 | 0.1%, 0.1W, 50V, Thin | Bourns | CRT0603-BY-1003ELF | 100kΩ | 0603 |
| 45 | 2 | R107, R407 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF7501V | 7.5kΩ | 0603 |
| 46 | 5 | R108, R208, R308, R408, R508 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603-FX-1743ELF | 174kΩ | 0603 |
| 47 | 2 | R109, R409 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF8660V | 866Ω | 0603 |
| 48 | 5 | R110, R210, R310, R410, R510 | 1%, 0.1W, 50V, Thick film | KOA Speer | RK73H1JTTD4R70F | 4.7Ω | 0603 |
| 49 | 2 | R111, R411 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603-FX-2150ELF | 215Ω | 0603 |
| 50 | 8 | R112, R212, R312, R412, R512, R614, R713, R806 | 1%, 0.1W, 50V, Thick film | Vishay/Dale | CRCW060350R0FKEA | 50Ω | 0603 |
| | | R214, R807, | Zero ohms | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 51 | 4 | R808, R809 | jumper, 1A, 155°C | KOA Speer | RS0603FR-070RL | 0Ω | 0603 |
| 52 | 16 | R115, R116, R215, R216, R315, R316, R415, R416, R515, R516, R615, R616, R715, R716, R815, R816 | Zero ohms jumper, 2A, 155°C | KOA Speer | RK73Z2BTTD | 0Ω | 1206 |
| 53 | 1 | R205 | 0.1%, 0.1W, 75V, Thin film | Vishay | TNPW060382K5BEEA | 82.5kΩ | 0603 |
| 54 | 1 | R207 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF6191V | 6.19kΩ | 0603 |
| 55 | 2 | R209, R511 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF4750V | 475Ω | 0603 |
| 56 | 1 | R211 | 1%, 0.1W, 50V, Thick | Bourns | CR0603FX-2940ELF | 294Ω | 0603 |
| 57 | 1 | R307 | 1%, 0.1W, 75V, Thick film | Panasonic | 667-ERJ-3EKF4021V | 4.02kΩ | 0603 |
| 58 | 2 | R309, R802 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603FX-5231ELF | 5.23kΩ | 0603 |
| 59 | 1 | R311 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603FX-5900ELF | 590Ω | 0603 |
| 60 | 1 | R317 | 22.1kΩ, 1%, 0.1W, 50V, Thick film | Panasonic | ERJ-3EKF2212V | DNP | 0603 |
| 61 | 1 | R318 | 14.3kΩ, 1%, 0.1W, 50V, Thick film | Panasonic | ERJ-3EKF1432V | DNP | 0603 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 62 | 1 | R504 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF2213V | 221kΩ | 0603 |
| 63 | 1 | R505 | 0.1%, 1/16W, 75V, Thin film | Susumu | RG1608P-3162-B-T5 | 31.6kΩ | 0603 |
| 64 | 1 | R507 | 1%, 0.1W, 75V, Thick film | Vishay | CRCW06033K24FKEA | 3.24kΩ | 0603 |
| 65 | 1 | R601 | 0.1%, 0.1W, 150V, Thin film | Panasonic | ERA-3AEB2742V | 27.4kΩ | 0603 |
| 66 | 3 | R602, R701, R702 | 0.1%, 0.06W, 75V, Thin film | Susumu | RG1608P-3482-B-T5 | 34.8kΩ | 0603 |
| 67 | 2 | R603, R703 | 1%, 0.1W, 50V, Thick film | Bourns | CR0603-FX-1201ELF | 1.2kΩ | 0603 |
| 68 | 2 | R606, R706 | 1%, 0.1W, 50V, Thick film | KOA Speer | RK73H1JTTD1303F | 130kΩ | 0603 |
| 69 | 2 | R607, R707 | 1%, 0.1W, 75V, Thick film | Panasonic | ERJ-3EKF1503V | 150kΩ | 0603 |
| 70 | 3 | R612, R712 | 1%, 0.1W, 75V, Thick film | KOA Speer | RK73H2BTTD2R21F | 2.21Ω | 1206 |
| 71 | 1 | R810 | | | | DNP | 0603 |
| 72 | 1 | R613 | 0.1%, 0.1W, 150V, Thin film | Panasonic | ERA-3AEB154V | 150kΩ | 0603 |
| 73 | 1 | R801 | 1%, 0.1W, 150V, Thick film | Panasonic | ERJ-3EKF47R0V | 47Ω | 0603 |
| 74 | 1 | R804 | 0.1%, 0.06W, 75V, Thin film | Panasonic | ERA-3AEB2322V | 23.2kΩ | 0603 |
| 75 | 1 | R805 | 0.1%, 0.1W, 50V, Thin film | Bourns | CRT0603-BY-1002ELF | 10kΩ | 0603 |
| | | U101, U201, | Current- | | | | 40-pin |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 76 | 5 | U301, U401, U501 | mode, PWM stepdown | Maxim | MAX8686ETL+ | MAX8686 | TQFN-EP |
| 77 | 2 | U601, U701 | Current-mode, PWM stepdown | Maxim | MAX8654ETX+ | MAX8654 | 36-pin TQFN-EP |
| 78 | 1 | U801 | Current-mode, PWM stepdown | Maxim | MAX15041ETE+ | MAX15041 | 16-pin TQFN-EP |
| 79 | 1 | PCB | MAXIM KINTEX7 Maxim Power Module Rev, 1 | PC Process | MAXIM KINTEX7 Maxim Power Module Rev, 1 | | |

## Board Image




More detailed image. (PDF, 2.4MB)

| Related Parts | | |
|---|---|---|
| MAX15041 | Low-Cost, 3A, 4.5V to 28V Input, 350kHz, PWM Step-Down DC-DC Regulator with Internal Switches | Free Samples |
| MAX8654 | 12V, 8A, 1.2MHz, Step-Down Regulator | Free Samples |
| MAX8686 | Single/Multiphase, Step-Down, DC-DC Converter Delivers Up to 25A Per Phase | Free Samples |

**More Information**
For Technical Support: http://www.maximintegrated.com/support
For Samples: http://www.maximintegrated.com/samples
Other Questions and Comments: http://www.maximintegrated.com/contact

Application Note 5448: http://www.maximintegrated.com/an5448
REFERENCE DESIGN 5448, AN5448, AN 5448, APP5448, Appnote5448, Appnote 5448