PR271

Virtex-II Pro™ Design 4

TPS40021 DC/DC Controller-based Power Management Solution Providing I_{CCINT} = 20A from V_{IN} = 5 V

FEATURES:

- Powers one or more FPGAs
- High efficiency minimizes heat
- Flexible controller (TPS40021) design allows optimization for size, power dissipation and cost
- Interchange SWIFT™ (TPS54xxx) device to support 1.5 A to 9 A load currents
  - 1.5A and 3A synchronous SWIFT devices are pin-pin compatible
  - 6A, 8A, and 9A synchronous SWIFT devices are pin-pin compatible
- Use of the TPS54x10 adjustable devices allow
  - use of smallest inductor and/or specific type of output capacitor
  - flexibility to re-compensate as needed, depending on the bypass/decoupling capacitors used with the FPGA
- In-rush current (for charging decoupling caps and FPGA start-up) that places a demand on the input power supply is minimized by the use of optional
  - Integrated soft-start configured with an capacitor to provide 10 ms rise time for V_{CCINT} and V_{CCO}
  - Sequential sequencing of V_{CCINT}, V_{CCAUX} and then V_{CCO} using PWRGD and ENABLE of each device
- High UVLO trip point and integrated soft-start of the 40K and SWIFT™ devices eliminates the need for an external Supply Voltage Supervisor (SVS) to monitor the input rail.
- Additional V_{CCO} rails easily added and sequenced (if desired) using the TPS54xxx PWRGD and ENABLE.
- RocketIO™ powered by ultra-low noise, high PSRR (for rejecting noise at the input from translating to the output) low dropout linear regulators (LDOs), TPS79xxx and TPS786xx. This series has been qualified by Xilinx to replace LT1963.
- The design meets Xilinx's V_{CCINT} and V_{CCO} start-up profile requirements, where applicable, including monotonic voltage ramp, in-rush current and power voltage ramp time requirements.

IMPORTANT WEB LINKS:

- Link to the TI home page for Xilinx FPGA power management solutions at http://www.ti.com/xilinxfpga for more information and other reference designs.
- Link to the datasheets at http://focus.ti.com/lit/ds/symlink/TPS40021.pdf and http://focus.ti.com/lit/ds/symlink/TPS54310.pdf

- Link to 40K design software tool at http://focus.ti.com/docs/toolsw/folders/print/tps40k-sw.html to assist further optimization/customization of design.
- Link to SWIFT™ design software tool at http://focus.ti.com/docs/toolsw/folders/print/swift-sw.html to assist further optimization/customization of design.

IMPLEMENTATION NOTES:

- **Sequencing:** Although Xilinx FPGAs **do NOT require it**, this reference design employs sequencing. This practice is consistent with good power supply design and prevents the input power supply from being pulled down due to in-rush currents for charging large capacitive loads.
- **Additional Capacitance:**
  - TheTPS40021s have been compensated to allow for up to the following additional capacitance on each rail:
    - 22 uF in ceramics in parallel with
    - two 470 uF capacitors, each with ESR between 0.1 and 2 ohms.

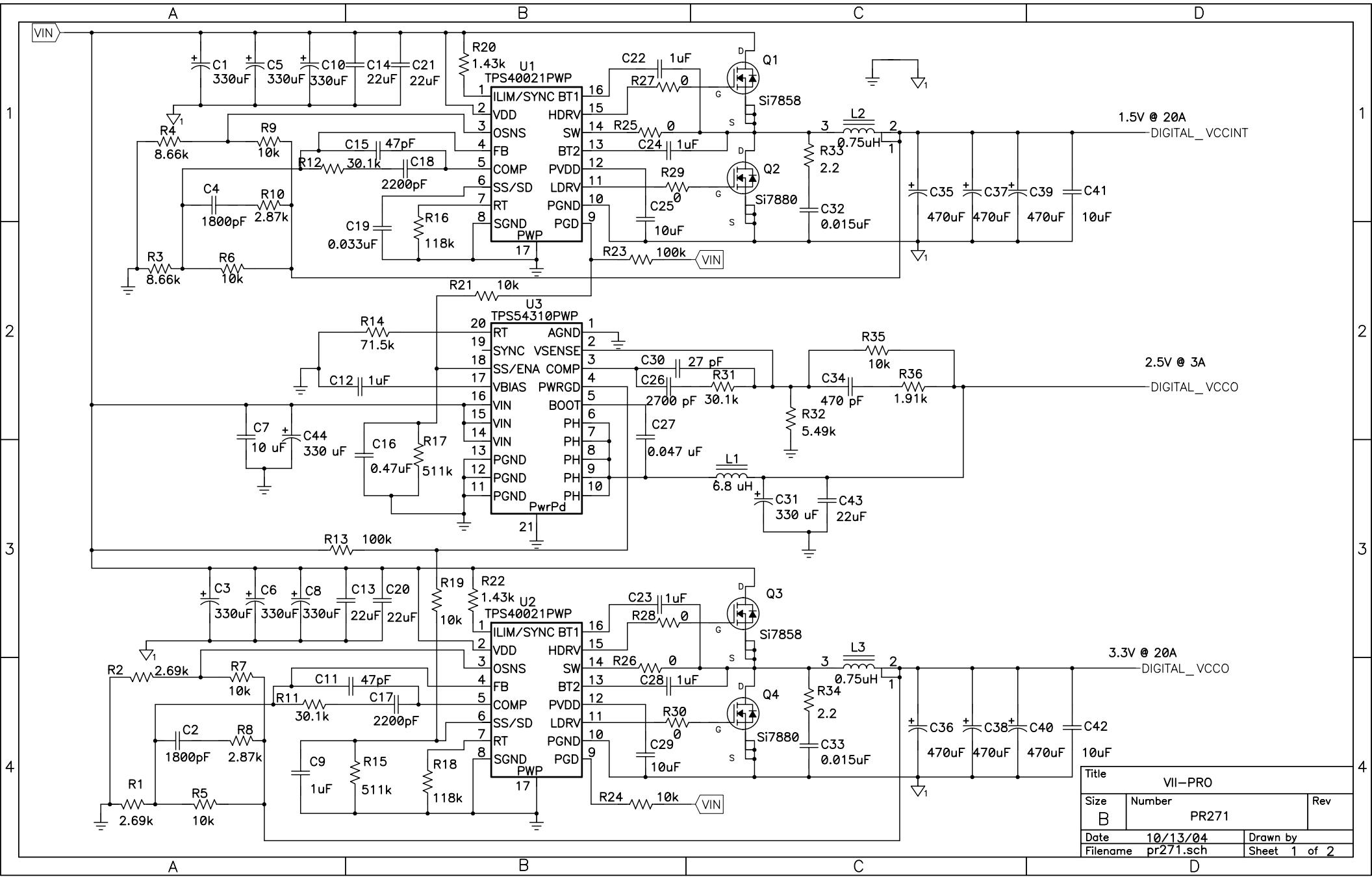
    If more bypass capacitance or bulk capacitors with ESR outside the range above is used, each TPS40021 may require re-compensation using the 40k design software.
  - The TPS54310s have been compensated to allow for up to the following additional capacitance on each rail:
    - 12 uF in ceramics in parallel with
    - two 330 uF capacitors, each with ESR between 0.1 and 2 ohms.

    If more bypass capacitance or bulk capacitors with ESR outside the range above is used, each *TPS54310* may need re-compensation using the SWIFT™ design software.
- **V_{CCAUX} :** V_{CCAUX} powers time-critical resources in the FPGA, including the Digital Clock Managers (DCMs). Therefore, this supply voltage is especially susceptible to power supply noise. V_{CCAUX} can share a power plane with V_{CCO}, but only if V_{CCO} does not have excessive noise. Changes in V_{CCAUX} voltage beyond 200 mV peak-to-peak should take place no faster than 10 mV per milli-second.
- **RocketIO**: When powering the RocketIO:
  - $A_{VCCAUXTX}$, $V_{CCAUXRX}$, A_{VTRX}, and A_{VTTX} may each be powered by their own linear regulator or by the same regulator if their voltages are the same. Keep power dissipation capability of the linear regulator package in mind.
  - Select the appropriate TPS79xxx based on the load current requirement, and the power dissipation capability of the package. In general, the lower the current rating, the lower the price of the linear regulator. Power dissipation of linear regulators is explained in TI Application Note SLVA118.

    - For the TPS79x01 adjustable devices, size the feedback resistors according to the datasheet. These resistors are not populated in the schematic.
    - All unused RocketIO transceivers must be connected to power (2.5V) and ground.
- **Modifications:** Adapt to V_{IN} = 3.3 V by removing U2

QUESTIONS?

- Send an email to mailto:**fpgasupport@list.ti.com**


VIN
C1 330uF
C5 330uF
C10 330uF
C14 22uF
C21 22uF
R20 1.43k
U1
TPS40021PWP
ILIM/SYNC BT1
VDD HDRV
OSNS SW
FB BT2
COMP PVDD
SS/SD LDRV
RT PGND
SGND PGD
PWP
C22 1uF
R27 0
Q1
Si7858
R25 0
C24 1uF
L2
0.75uH
1.5V @ 20A
DIGITAL_VCCINT
R33 2.2
Q2
Si7880
R29 0
C25 10uF
C32 0.015uF
C35 470uF
C37 470uF
C39 470uF
C41 10uF
R4 8.66k
R9 10k
C15 47pF
R12 30.1k
C18 2200pF
C4 1800pF
R10 2.87k
C19 0.033uF
R16 118k
R3 8.66k
R6 10k
R23 100k
R21 10k
U3
TPS54310PWP
RT AGND
SYNC VSENSE
SS/ENA COMP
VBIAS PWRGD
VIN BOOT
VIN PH
VIN PH
PGND PH
PGND PH
PGND PH
PwrPd
R14 71.5k
C12 1uF
C30 27 pF
C26 2700 pF
R31 30.1k
R35 10k
C34 470 pF
R36 1.91k
2.5V @ 3A
DIGITAL_VCCO
R32 5.49k
C7 10 uF
C44 330 uF
C16 0.47uF
R17 511k
C27 0.047 uF
L1
6.8 uH
C31 330 uF
C43 22uF
R13 100k
C3 330uF
C6 330uF
C8 330uF
C13 22uF
C20 22uF
R19 10k
R22 1.43k
U2
TPS40021PWP
C23 1uF
R28 0
Q3
Si7858
R26 0
C28 1uF
L3
0.75uH
3.3V @ 20A
DIGITAL_VCCO
R34 2.2
Q4
Si7880
R30 0
C29 10uF
C33 0.015uF
C36 470uF
C38 470uF
C40 470uF
C42 10uF
R2 2.69k
R7 10k
C11 47pF
R11 30.1k
C17 2200pF
C2 1800pF
R8 2.87k
C9 1uF
R15 511k
R18 118k
R1 2.69k
R5 10k
R24 10k
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Rev
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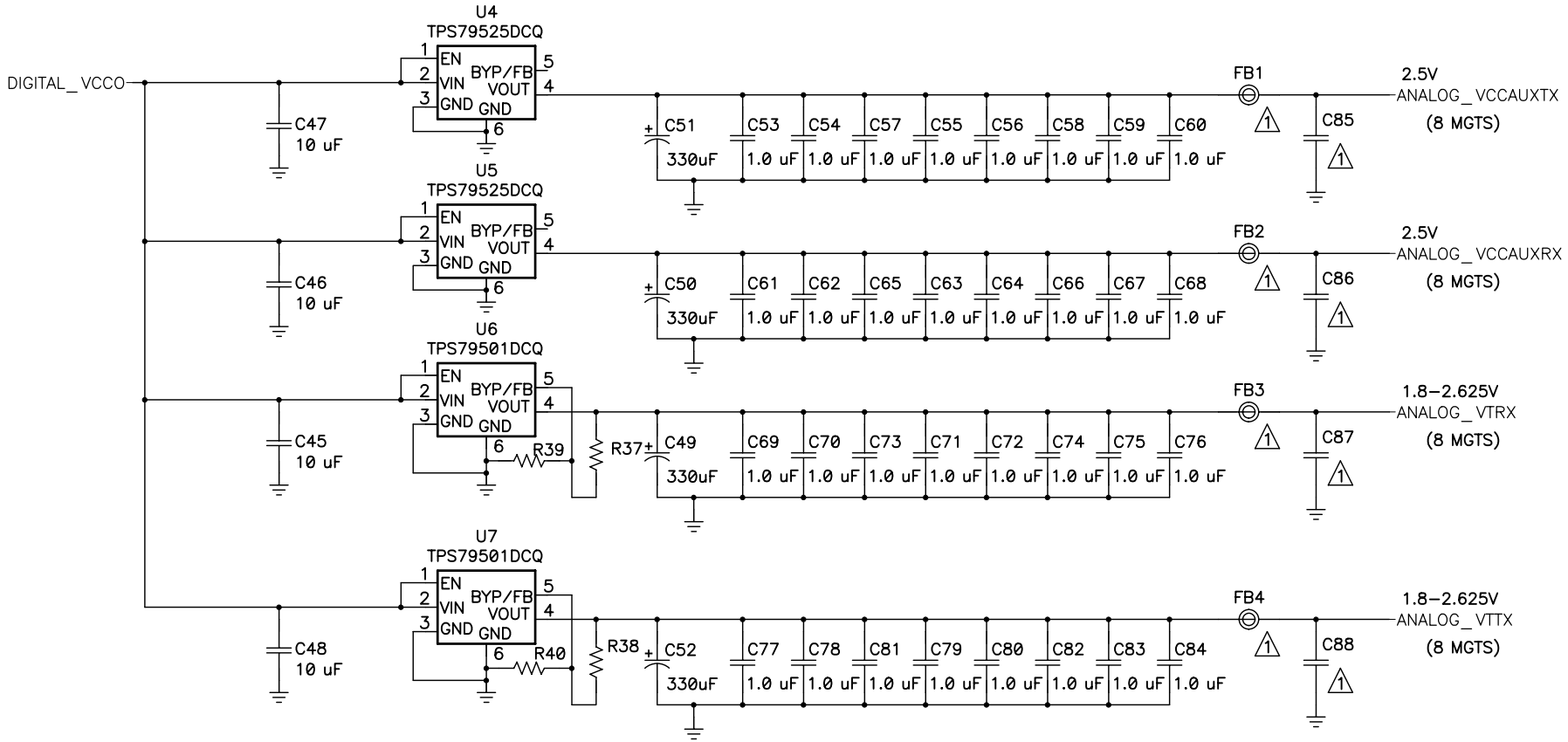
Sheet 1 of 2



⚠1 Refer to Xilinx's Rocket IO Tranceiver User Guide (UG024) for component values

Title	VII–PRO	
Size B	Number PR271	Rev
Date 10/13/04		Drawn by
Filename pr271.sch		Sheet 2 of 2

Filename: PR271_bom.xls

Date: 04/22/2004

PR271 BOM

COUNT	RefDes	DESCRIPTION	SIZE	MFR	PART NUMBER
6	C1, C3, C5, C6, C8, C10	Capacitor, POSCAP, 330-uF, 6.3-V, 10-milliohm, 20%	7343 (D)	Sanyo	6TPD330M
2	C11, C15	Capacitor, Ceramic, 47-pF, 50-V, C0G, 5%	603	muRata	GRM1885C1H470JA01D
3	C12, C24, C28	Capacitor, Ceramic, 1-uF, 10-V, X7R, 10%	805	Taiyo Yuden	LMK212BJ105KD
2	C17, C18	Capacitor, Ceramic, 2200-pF, 25-V, X7R, 5%	603	Vishay	VJ0603Y222JXXAT
1	C19	Capacitor, Ceramic, 0.033-uF, 25-V, X7R, 5%	603	Vishay	VJ0603Y333JXXAT
2	C2, C4	Capacitor, Ceramic, 8200-pF, 25-V, X7R, 5%	603	Vishay	VJ0603Y822JXXAT
2	C22, C23	Capacitor, Ceramic, 1-uF, 10-V, X7R,10%	805	Taiyo Yuden	LMK212BJ105KD
4	C25, C29, C41, C42	Capacitor, Ceramic, 10-uF, 6.3-V, 20%	1206	Taiyo Yuden	JMK316BJ106ML
1	C26	Capacitor, Ceramic, 2700-pF, 50-V, C0G, 5%	603	Vishay	GRM1885C1H272JA01D
1	C27	Capacitor, Ceramic, 0.047-uF, 25-V, X7R, 10%	603	Vishay	VJ0603Y473KXXAB00
1	C30	Capacitor, Ceramic, 27-pF, 50-V, C0G, 5%	603	muRata	GRM1885C1H270JA01D
2	C31, C44	Capacitor,Tantalum, 330-uF, 6.3-V, 600-milliohm, 20%	7343(D)	Vishay	293D337X96R3D2
2	C32, C33	Capacitor, Ceramic, 0.015-uF, 25-V, X7R, 5%	603	Vishay	VJ0603153KXXAT
1	C34	Capacitor, Ceramic, 470-pF, 50-V, C0G, 5%	603	muRata	GRM1885C1H471JA01D
6	C35, C36, C37, C38, C39, C40	Capacitor, POSCAP, 470-uF, 2.5-V, 10-milliohm, 20%	7343 (D)	Sanyo	2R5TPD470M
8	C45, C46, C47, C48, C49, C50, C51, C52	Capacitor, Ceramic, 2.2-uF, 6.3-V, X5R, 10%	805	muRata	GRM21BR60J225KC01
1	C7	Capacitor, Ceramic, 10-uF, 6.3-V, X5R, 10%	805	muRata	GRM21BR60J106KE01
7	C9, C13, C14, C16, C20, C21, C43	Capacitor, Ceramic, 22-uF, 6.3-V, 20%	1210	Taiyo Yuden	JMK325BJ226MM
1	L1	Inductor, SMT, 6.8-uH, 4.9-A, 23-milliohm		Coilcraft	MSS1260-682MXD
2	L2, L3	Inductor, SMT, 0.75-uH, 24-A, 3-milliohms	0.598 x 0.638	Sumida	CDEP149-0R7
2	Q1, Q3	MOSFET, NChannel, 12V, 29A, 3.0 millohm	PWRPAK S0-8	Siliconix	Si7858DP
2	Q2, Q4	MOSFET, NChannel, 30V, 29A, 3millohm	PWRPAK S0-8	Siliconix	Si7880DP
2	R1, R2	Resistor, Chip, 2.69k-Ohms, 1/16-W, 1%	603	Std	Std
3	R11, R12, R31	Resistor, Chip, 30.1k-Ohms, 1/16-W, 1%	603	Std	Std
2	R13, R23	Resistor, Chip, 100k-Ohms, 1/16-W, 1%	603	Std	Std

1	R14	Resistor, Chip, 71.5k-Ohms, 1/16-W, 1%	603	Std	Std
2	R15, R17	Resistor, Chip, 511k-Ohms, 1/16-W, 1%	603	Std	Std
2	R16, R18	Resistor, Chip, 118k-Ohms, 1/16-W, 1%	603	Std	Std
2	R20, R22	Resistor, Chip, 1.43k-Ohms, 1/16-W, 1%	603	Std	Std
6	R25, R26, R27, R28, R29, R30	Resistor, Chip, 0-Ohms, 1/16-W, 1%	603	Std	Std
2	R3, R4	Resistor, Chip, 8.66k-Ohms, 1/16-W, 1%	603	Std	Std
1	R32	Resistor, Chip, 5.49k-Ohms, 1/16-W, 1%	603	Std	Std
2	R33, R34	Resistor, Chip, 2.2-Ohms, 1/10-W, 1%	805	Std	Std
1	R36	Resistor, Chip, 1.91k-Ohms, 1/16-W, 1%	603	Std	Std
0	R37, R38, R39, R40	Resistor, Chip, xx-Ohms, 1/16-W	603		
8	R5, R6, R7, R9, R19, R21, R24, R35	Resistor, Chip, 10k-Ohms, 1/16-W, 1%	603	Std	Std
2	R8, R10	Resistor, Chip, 2.87k-Ohms, 1/16-W, 1%	603	Std	Std
2	U1, U2	IC, Enhanced, Low Input Voltage-Mode, Synchronous Buck Controller	HTSSOP-16	TI	TPS40021PWP
1	U3	IC, IFET Power Controller, Adj-V, 3A	PWP20	TI	TPS54310PWP
2	U4, U5	IC, LDO Linear Regulator Ultralow-Noise High PSRR Fast RF, 500mA, 2.5V	SOT223-6	TI	TPS79525DCQ
2	U6, U7	IC, Utralow-Noise, High PSRR, Fast RF 250 mA, LDO Linear Regulators, AdjV	SOT223-6	TI	TPS79401DCQ

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