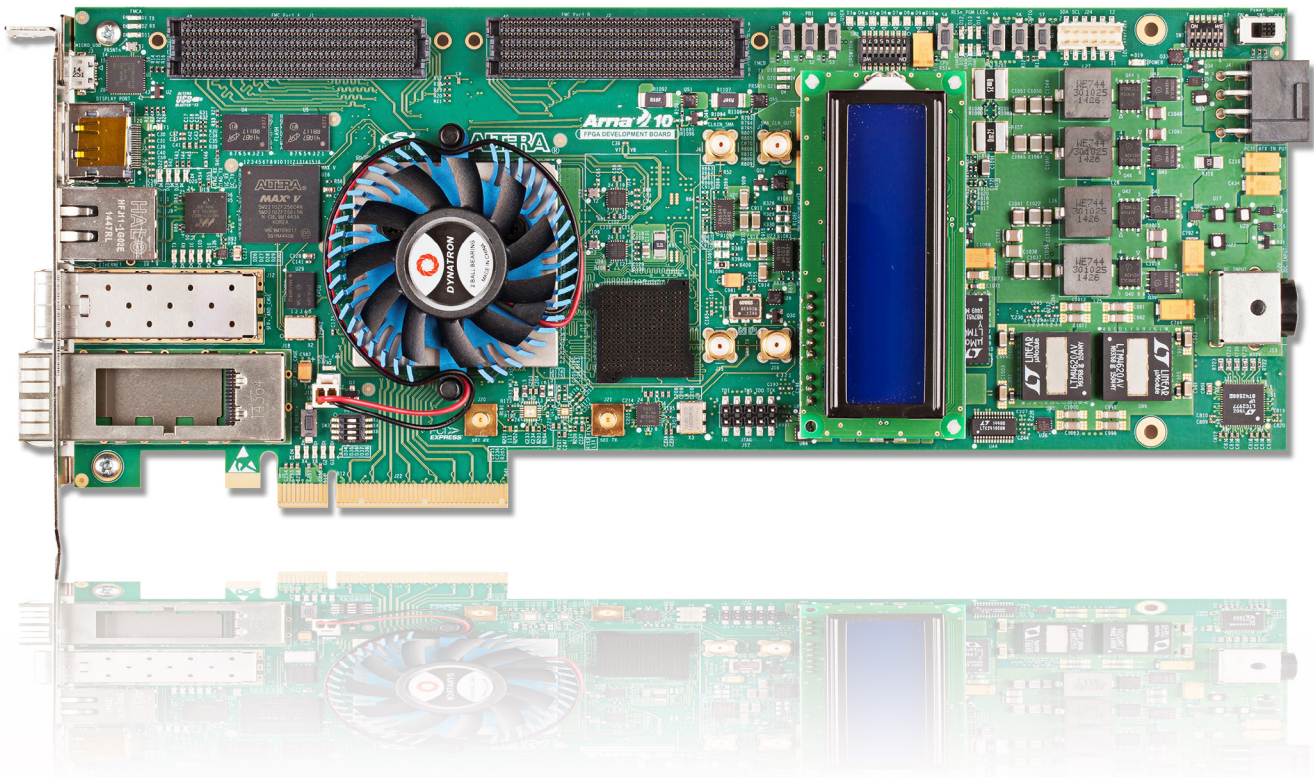


Power Management Solutions for Altera FPGAs

Tested and Verified

- ▣ Schematics
- ▣ Bill-of-Materials
- ▣ Power Circuit Simulation & Design Tools
- ▣ www.linear.com/Altera

Altera Arria® 10 GX FPGA Development Kit



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Altera Development Boards.....	4-13
Power Circuit Simulation & Design Tool	14-15

Introduction

Power management solutions presented here have been assembled and verified by Altera® or third-party FPGA development board providers. Each development board is accompanied by a photo of the board, power tree and its Linear Technology bill-of-materials. For more information and technical documentation, visit www.linear.com/Altera.

Development Boards in this Brochure Can Be Found at linear.com/Altera

FPGA	Board Supplier	Product Name	Part Number for FPGA Core	Page
Arria® 10	Altera	Arria 10 GX FPGA Development Kit	LTC®3877 + LTC3874	4
Arria 10 SoC		Arria 10 SoC Development Kit	LTM®4677	5
Stratix® V		100G Development Kit, Stratix V GX Edition	LTM4627	6
		Stratix V GX FPGA Development Kit	LTC3880	7
		Stratix V Advanced Systems Development Kit	LTM4620	8
	Terasic®	DE5-Net FPGA Development Kit	LTM4628	9
Cyclone® V		DE0-Nano-SoC Kit/Atlas-SoC Kit	LTC3612	10
MAX® 10		MAX 10 NEEK	LTC3612	11

Development Boards Listed on the Board Supplier's Website

FPGA	Board Supplier	Product Name	Part Number for FPGA Core	Page
Stratix V	Altera	Transceiver Signal Integrity Development Kit, Stratix V GX Edition	LTC3855	12
		Transceiver Signal Integrity Development Kit, Stratix V GT Edition	LTC3880	12
		DSP Development Kit, Stratix V Edition	LTC3855	12
	Terasic	TR5-F40W FPGA Development Kit	LTM4628	12
		TR5-Lite FPGA Development Kit	LTM4628	12
Arria V	Altera	Arria V GX FPGA Starter Kit	LTC3880	12
		Arria V GX FPGA Development Kit	LTC3880	12
		Arria V GT FPGA Development Kit	LTC3880	12
Arria V SoC		Arria V SoC Development Kit and SoC Embedded Design Suite	LTC3866	13
Cyclone V E		Cyclone V E FPGA Development Kit	LTC3608	13
Cyclone V GX	Terasic	Cyclone V GT FPGA Development Kit	LTC3613	13
		Cyclone V GX Starter Kit	LTC3605	13
Cyclone V SoC	Altera	Cyclone V SoC Development Kit Rev C	LTC3613	13
	Terasic	DE1-SoC Development Kit	LTC3608	13
	Arrow®	SoC Kit Development Kit	LTC3608	13
	Macnica®	Helio Base Board	LTC3613	13

Contact board supplier to purchase the board

Altera: www.altera.com



Arrow: www.arrow.com



Macnica: www.macnica.com



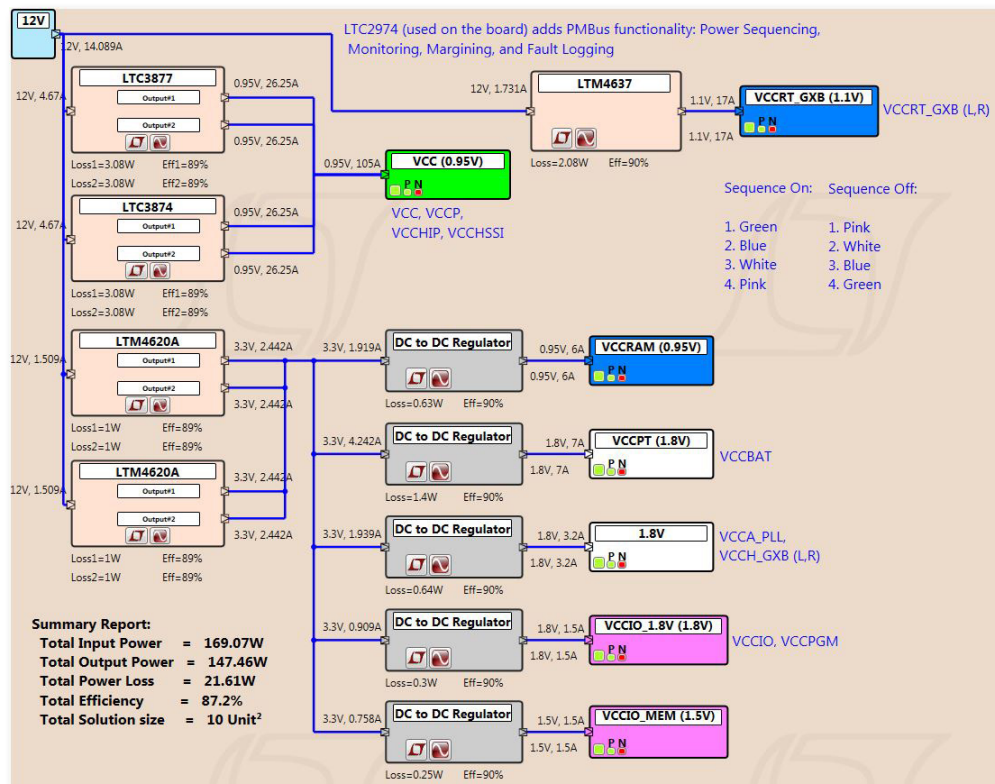
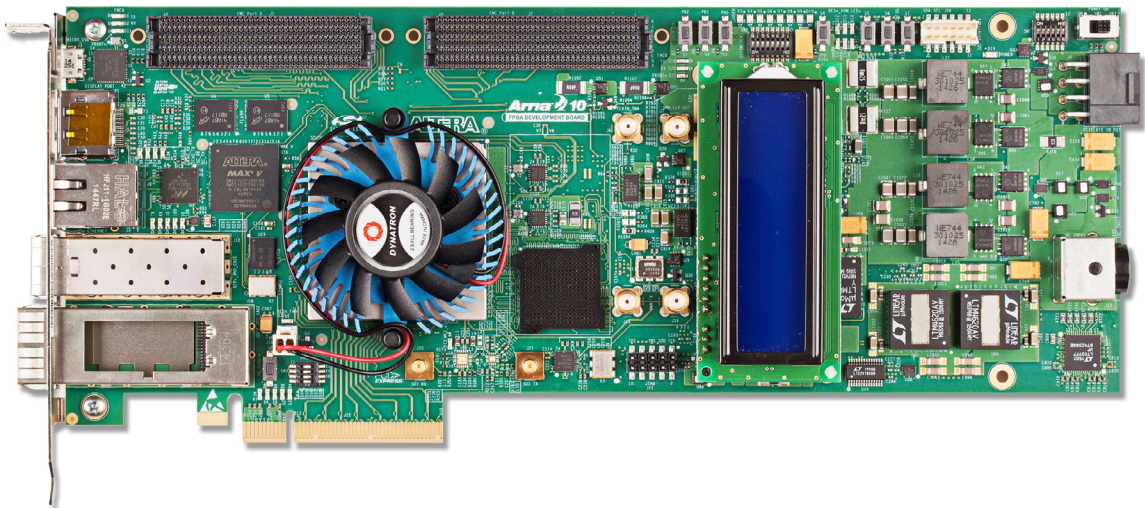
Terasic: www.terasic.com



Contact Linear Technology for schematics and design support: refdesign@linear.com

Arria 10 GX FPGA Development Kit

Altera's Arria 10 GX FPGA Development Kit delivers a complete design environment that includes all hardware and software you need to take advantage of the performance and capabilities available in Arria 10 GX FPGAs.

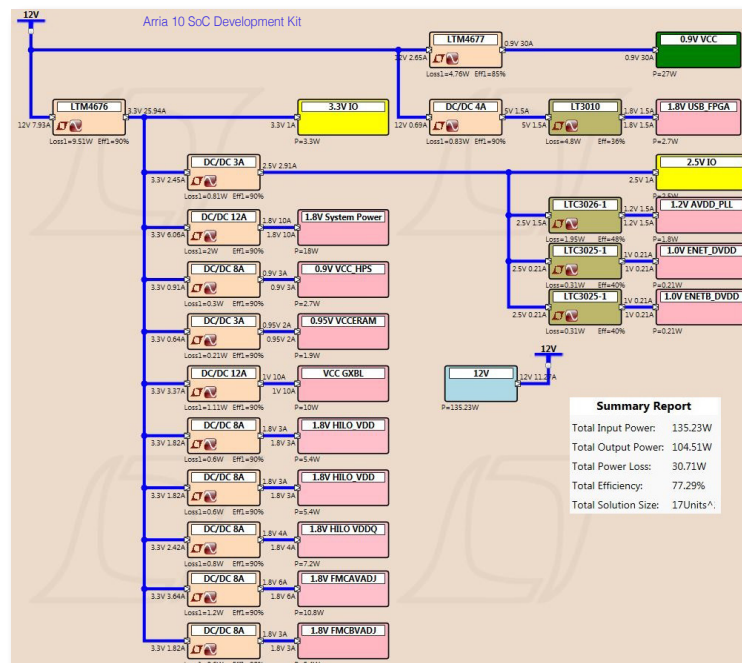
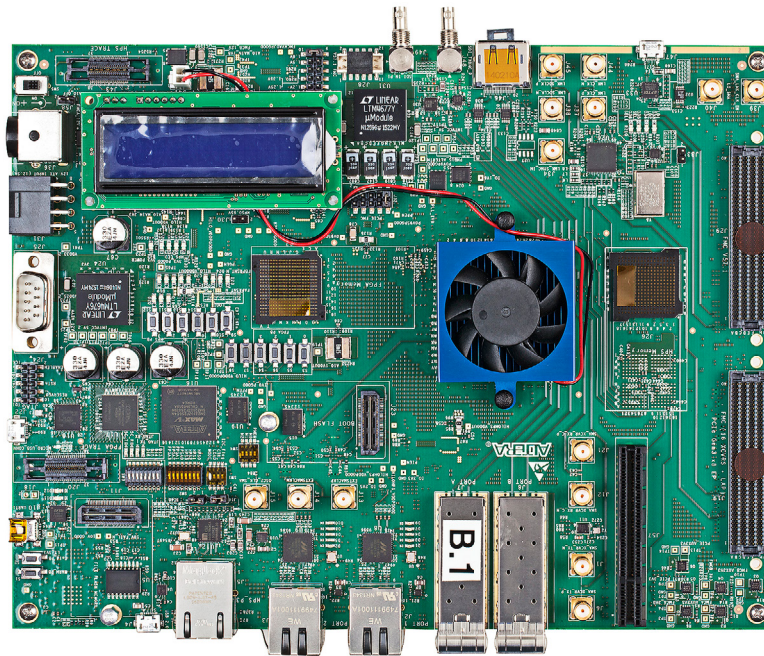


Power Tree designed in LTpowerPlanner®

Rail / Function	Part Number	General Description
0.95V: V _{CC} (FPGA Core)	LTC3877	Dual Phase Step-Down Synchronous Controller with VID Output Voltage Programming and Low Value DCR Sensing
	LTC3874	Polyphase Step-Down Synchronous Slave Controller with Sub-Milliohm DCR Sensing
1.1V: VCCRT_GXB	LTM4637	20A DC/DC Step-Down μModule® Regulator
3.3V: System Power	LTM4620A	Dual 13A or Single 26A DC/DC μModule Regulator
Power-Up/Down Sequencing, Power Monitoring, Voltage Margining and Fault Management	LTC2977	8-Channel PMBus Power System Manager Featuring Accurate Output Voltage Measurement
PowerPath™ Management	LTC4357	Positive High Voltage Ideal Diode Controller
Input Overvoltage Protection	LTC4365	Overvoltage, Undervoltage and Reverse Supply Protection Controller
Housekeeping System Power and Power Management	LT®3082, LTC4352, LTC3025-1, LTC2418, LT1389, LTC4315	Low Noise Linear Regulators, 24-Bit ADC; Low Voltage Ideal Diode. Voltage Reference. Bus Buffer

Arria 10 SoC Development Kit

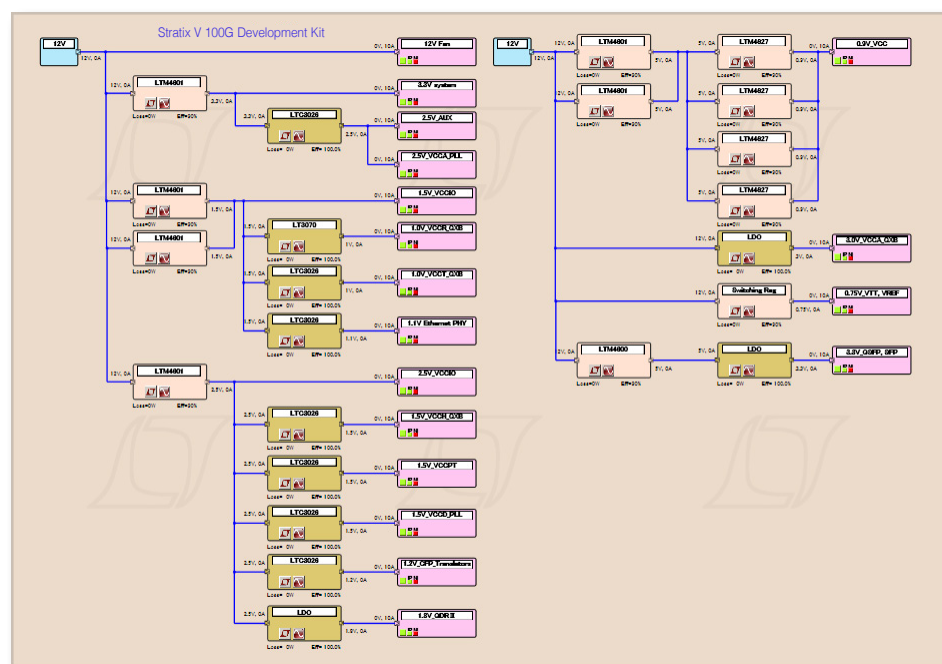
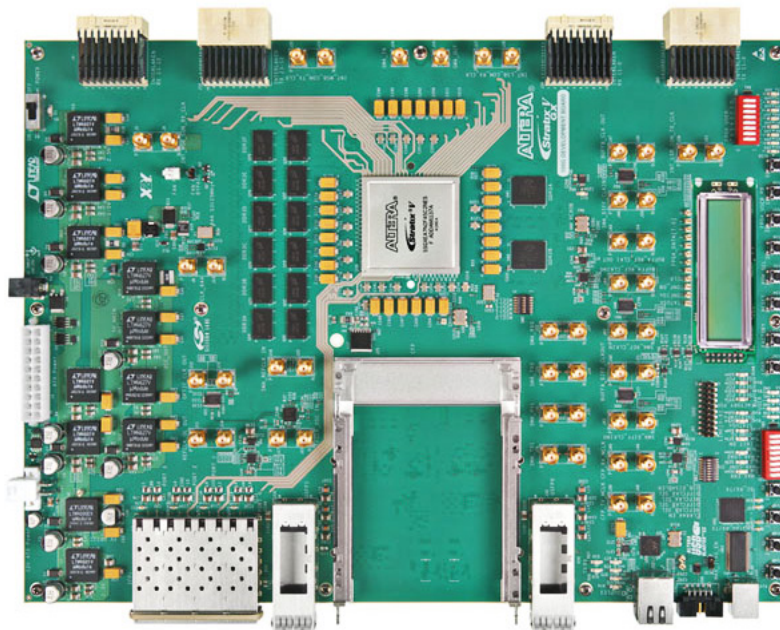
Altera's Arria 10 SoC Development Kit offers a quick and simple approach for developing custom ARM® processor-based SoC designs.



Power Tree designed in LTpowerPlanner

Rail / Function	Part Number	General Description
0.9V: V _{CC} (FPGA Core)	LTM4677	Dual 18A or Single 36A μ Module Regulator with Digital Power System Management
3.3V: System Power	LTM4676	Dual 13A or Single 26A μ Module Regulator with Digital Power System Management
1.2V: AVDD_PLL	LTC3026-1	1.5A Low Input Voltage VLDO™ Linear Regulator
1.0V: ENET_DVDD	LTC3025-1	500mA Micropower VLDO Linear Regulators
1.8V: USB_FPGA	LT3010	50mA, 3V to 80V Low Dropout Micropower Linear Regulator
Voltage Monitor and Control	LTC2977	8-Channel PMBus Power System Manager Featuring Accurate Output Voltage Measurement
16-Bit ADC for Analog Input	LTC2497	16-Bit 8-/16-Channel Delta-Sigma ADC with Easy Drive™ Input Current Cancellation and I ² C Interface
1.25V Voltage Reference	LT1389	Nanopower Precision Shunt Voltage Reference

Altera's 100G Development Kit, Stratix V GX Edition enables a thorough evaluation of 100G designs.

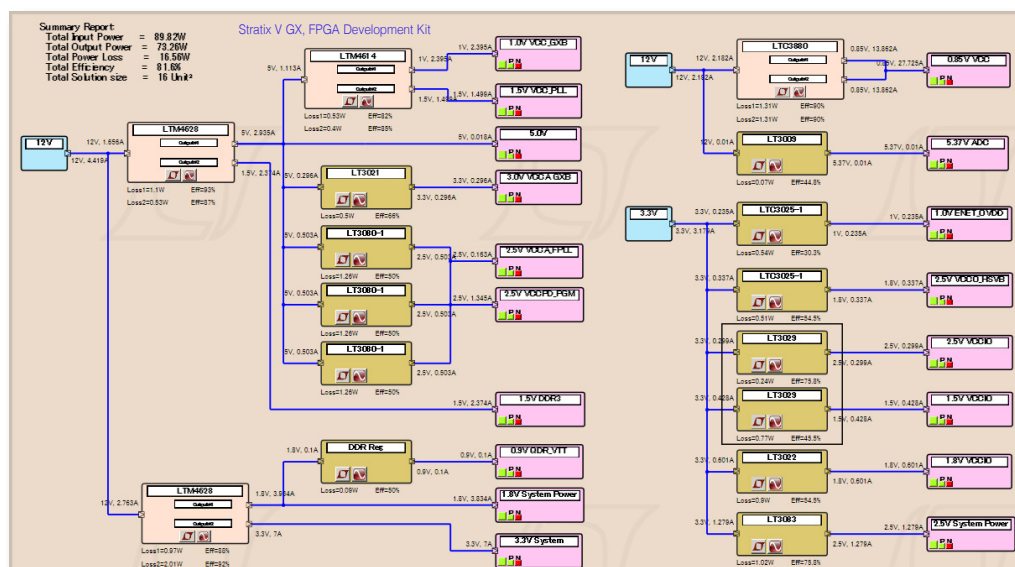
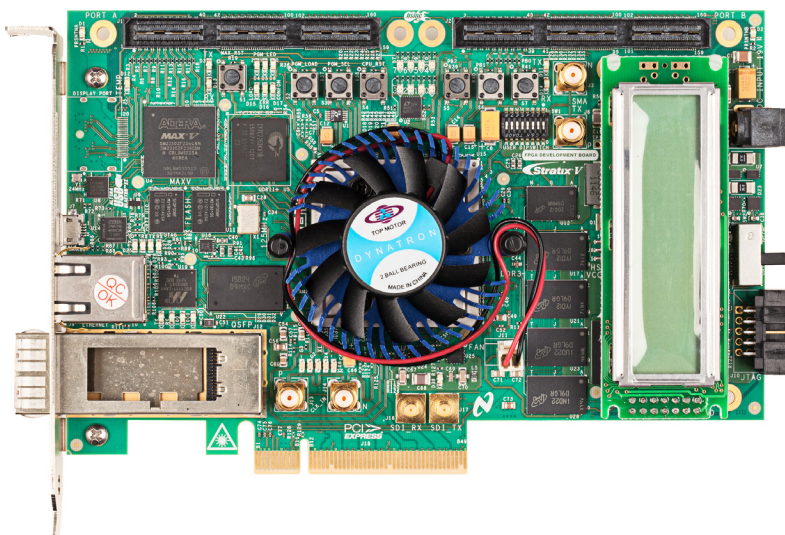


Power Tree designed in LTpowerPlanner

Rail / Function	Part Number	General Description
0.9V: V _{CC} (FPGA Core)	LTM4627	15A DC/DC μ Module Regulator
5V, 3.3V, 2.5V, 1.5V: System Power	LTM4601	12A μ Module Regulators with PLL, Output Tracking and Margining
5V: System Power	LTM4600	10A High Efficiency DC/DC μ Module
2.5V: VCCA_PLL, AUX 1.0V: VCCT_GXB 1.1V: Ethernet PHY 1.5V: VCCH_GXB, VCCPT, VCCD_PLL 1.2V: CFP Translators	LTC3026	1.5A Low Input Voltage VLDO Linear Regulator
1.0V: VCCR_GXB	LT3070	5A, Low Noise, Programmable Output, 85mV Dropout Linear Regulator
12V: System Power	LT1374	4.5A, 500kHz Step-Down Switching Regulator
Clock for μ Module Regulators	LTC6900	Low Power, 1kHz to 20MHz Resistor Set SOT-23 Oscillator
Housekeeping System Power and Power Management	LT1761 , LTC4357	Low Noise LDO, Ideal Diode

Stratix V GX, FPGA Development Kit

The Altera Stratix V GX FPGA Development Kit provides a complete design environment, including all the hardware and software you need to start developing FPGA designs.

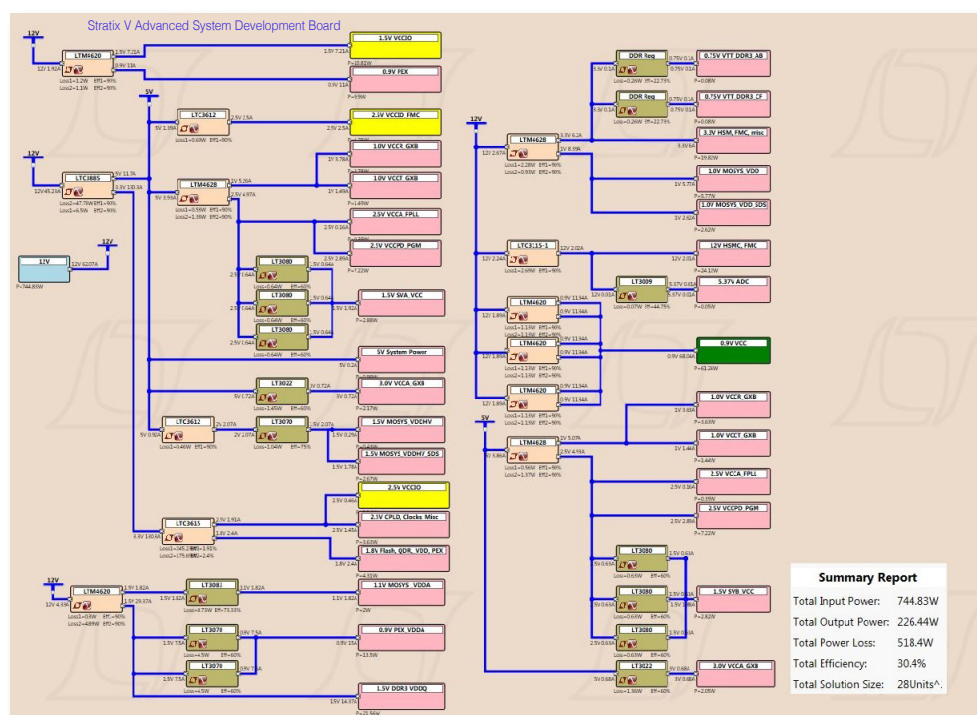


Power Tree designed in [LTpowerPlanner](#)

Rail / Function	Part Number	General Description
0.85V: VCCINT (FPGA Core)	LTC3880	Dual Output PolyPhase® Step-Down DC/DC Controller with Digital Power System Management.
5V: System Power	LT3009	3µA I _Q , 20mA Low Dropout Linear Regulators
5V, 3.3V, 1.8V, 1.5V: System Power	LTM4628	Dual 8A or Single 16A µModule Regulator
1.0V: VCCR, CVVT	LTM4614	Dual 4A per Channel Low V _{IN} DC/DC µModule Regulator
1.5V: VCCD_FPLL, VCCH_GXB, VCCPT	LT3021	500mA, Low Voltage, Very Low Dropout Linear Regulator
3.0V: VCCA_GXB	LT3080-1	Parallelable 1.1A Single Resistor Low Dropout Regulator
2.5V: VCCA_FPLL, VCCPD_PGM	LT3080-1	Parallelable 1.1A Single Resistor Low Dropout Regulator
12V, 3.3V: System Power	LTC3855	Dual, Multiphase Synchronous DC/DC Controller with Differential Remote Sense
1.0V: ENET_DVDD	LTC3025-1	300mA Micropower VLDO Linear Regulator
1.5V: VCCIO_HSMB	LTC3025-1	300mA Micropower VLDO Linear Regulator
2.5V: VCCIO	LT3029	Dual 500mA Low Dropout, Low Noise, Micropower Linear Regulator
1.5V: VCCIO	LT3029	Dual 500mA Low Dropout, Low Noise, Micropower Linear Regulator
1.8V: VCCIO	LT3022	1A, 0.9V to 10V, Very Low Dropout Linear Regulator
2.5V: System Power	LT3083	Adjustable 3A Single Resistor Low Dropout Regulator
Housekeeping System Power and Power Management	LTC2915, LTC2418, LTC4357, LTC2990, LTC4352	Voltage and Current Monitor, AD Converter, Hot Swap Controller, Ideal Diode

Stratix V Advanced Systems Development Kit

The Stratix V Advanced Systems Development Kit is a complete systems design environment, including both the hardware and software needed to start architecture development and system design using Stratix V FPGAs.

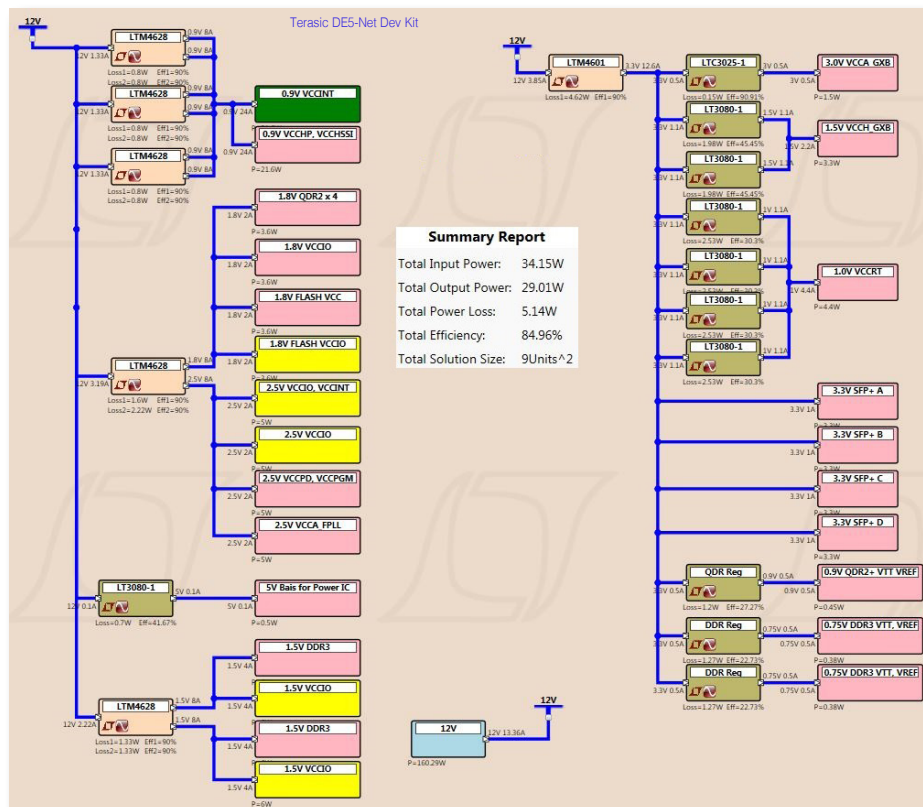
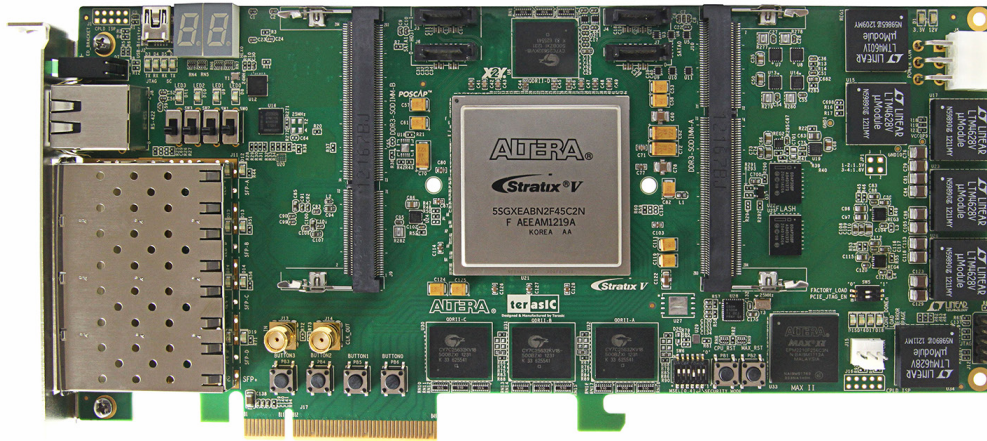


Power Tree designed in LTpowerPlanner

Rail / Function	Part Number	General Description
0.9V: V _{CC} (FPGA Core), PEX 1.5V: VCCIO, System Power	LTM4620	Dual 13A or Single 26A DC/DC μ Module Regulator
5V, 3.3V: System Power	LTC3855	Dual, Multiphase Synchronous DC/DC Controller with Differential Remote Sense
2.5V: VCCIO	LTC3612	3A, 4MHz Monolithic Synchronous Step-Down DC/DC Converter
1.0V: VCCT_GXB, VCCR_GXB 2.5V: VCCPD_PGM, VCCA_FPLL 3.3V: System Power	LTM4628	Dual 8A or Single 16A DC/DC μ Module Regulator
2.5V: VCCIO 1.8V: System Power	LTC3615	Dual 4MHz, 3A Synchronous Step-Down DC/DC Converter
12V: HSMC, FMC	LTC3115-1	40V, 2A Synchronous Buck-Boost DC/DC Converter
1.1V: MOSYS_VDDA	LT3083	Adjustable 3A Single Resistor Low Dropout Regulator
0.9V: PEX_VDDA 1.5V: MOSYS_VDDHV	LT3070	5A, Low Noise, Programmable Output, 85mV Dropout Linear Regulator
1.5V: VCCD_FPLL	LT3080-1	Parallelable 1.1A Adjustable Single Resistor Low Dropout Regulator
3.0V: VCCA_GXB	LT3022	1A, 0.9V to 10V, Very Low Dropout Linear Regulator
5.37V: ADC	LT3009	3 μ A I _O , 20mA Low Dropout Linear Regulators
Housekeeping System Power and Power Management	LTC4357, LTC4367, LTC4352	Hot Swap, OV UV Protection, Ideal Diode

Stratix V DE5-Net FPGA Development Kit

The Terasic DE5-Net Stratix V GX FPGA Development Kit provides the ideal hardware solution for designs that demand high capacity and bandwidth memory interfacing, ultralow latency communication and power efficiency.

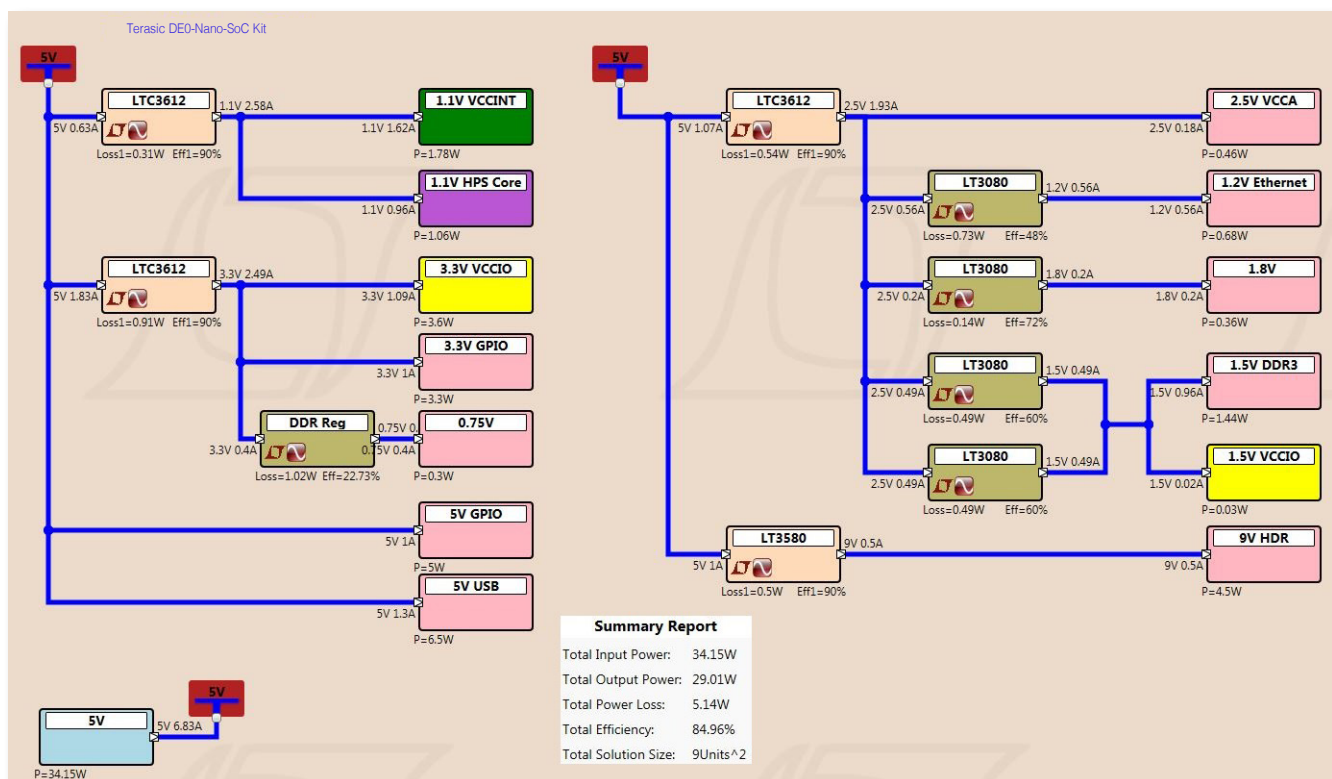
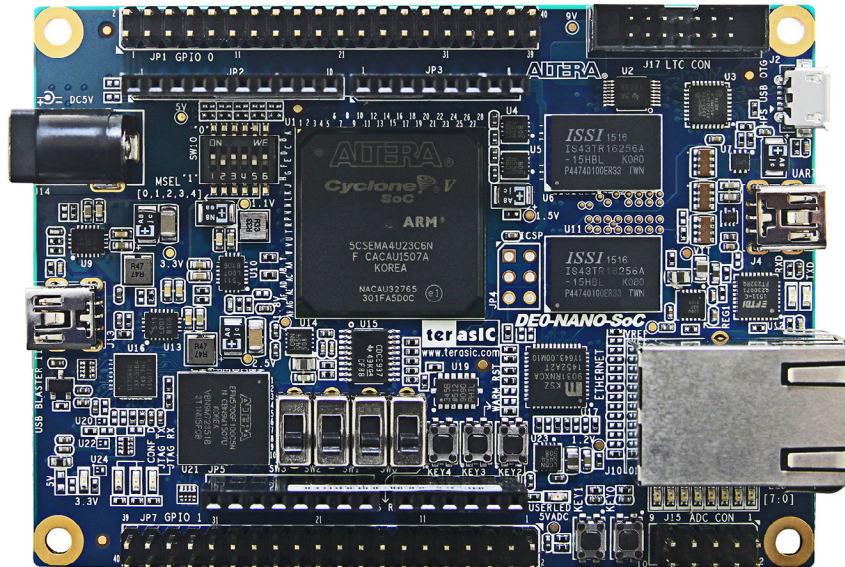


Power Tree designed in LTpowerPlanner

Rail / Function	Part Number	General Description
0.9V: VCCINT (FPGA Core) 1.8V: VCCIO 2.5V: VCCIO 1.5V: VCC for DDR3	LTM4628	Dual 8A or Single 16A μ Module Regulator
1.0V: VCCR, VCCT 1.5V: VCCD_FPLL 5.0V: Bias	LT3080-1	Parallelable 1.1A Adjustable Single Resistor Low Dropout Regulator
3.3V: System Power	LTM4601	12A μ Module Regulator with PLL, Output Tracking and Margining
3.0V: VCCA_GXB	LTC3025-1	500mA Micropower VLDO Linear Regulator
12V Power Source Selector	LTC4357	Positive High Voltage Ideal Diode Controller
	LTM4608	Low V_{IN} , 8A DC/DC μ Module Regulator with Tracking, Margining and Frequency Synchronization
RS485 Interface	LTC2855	3.3V 20Mbps RS485/RS422 Transceivers with Integrated Switchable Termination

Cyclone V, DE0-Nano-SoC Kit/Atlas SoC Kit

The DE0-Nano-SoC Development Kit presents a robust hardware design platform built around the Altera System-on-Chip (SoC) FPGA, which combines the latest dual-core Cortex-A9 embedded cores with industry-leading programmable logic for ultimate design flexibility.

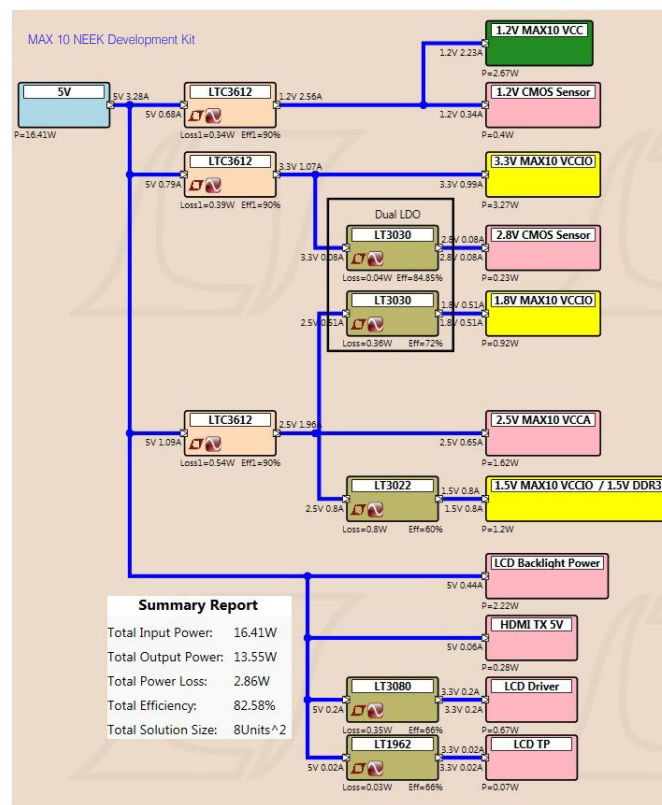
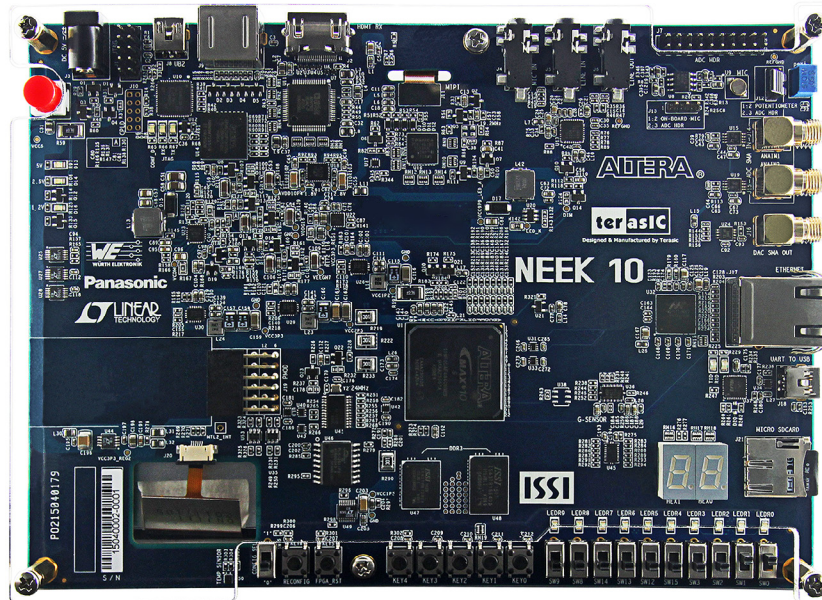


Power Tree designed in LTpowerPlanner

Rail / Function	Part Number	General Description
1.1V: VCCINT (FPGA Core) 1.1V: HPS Core (FPGA Hardened Core) 3.3V: VCCIO	LTC3612	3A, 4MHz Synchronous Step-Down DC/DC Converter
1.5V: VCCIO	LT3080	Adjustable 1.1A Single Resister Low Dropout Regulator
9V: HDR	LT3580	Boost/Inverting DC/DC Converter with 2A Switch, Soft-Start and Synchronization
External Analog Interface	LTC2308	Low Noise, 500ksps, 8-Channel, 12-Bit ADC

MAX10 NEEK

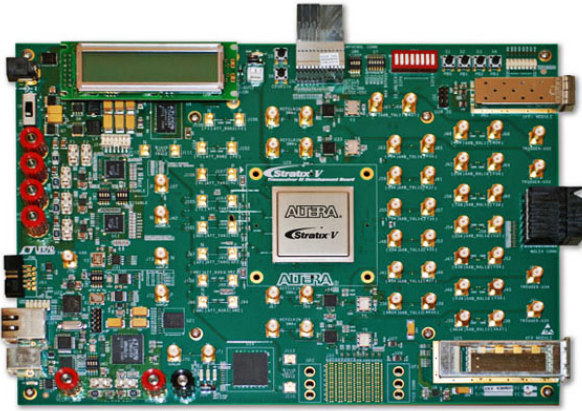
The MAX 10 Nios® II Embedded Evaluation Kit (NEEK) from Terasic is a full featured embedded evaluation kit based on the MAX 10 family of FPGAs. It is a comprehensive design environment with everything embedded developers need to create a processing-based system.



Power Tree designed in LTpowerPlanner

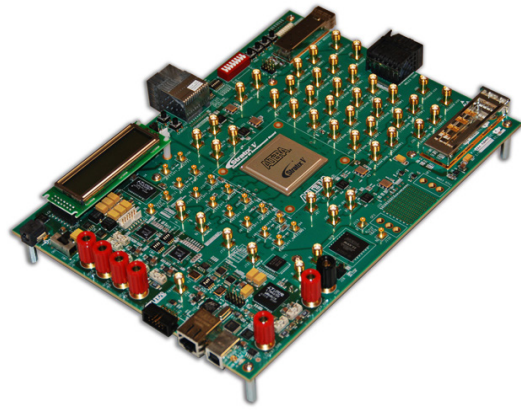
Rail / Function	Part Number	General Description
1.2V: V _{CC} (FPGA Core) 3.3V: VCCIO	LTC3612	3A, 4MHz Synchronous Step-Down DC/DC Converter
1.8V: VCCIO	LT3030	Dual 750mA/250mA Low Dropout, Low Noise, Micropower Linear Regulator
1.5V: VCCIO, DDR3	LT3022	1A, 0.9V to 10V, Very Low Dropout Linear Regulator
3.3V: LCD Driver	LT3080	Adjustable 1.1A Single Resistor Low Dropout Regulator
3.3V: LCD TP	LT1962	300mA, Low Noise, Micropower LDO Regulator
Current Monitor	LTC2990	Quad I ² C Voltage, Current and Temperature Monitor

Additional Development Boards



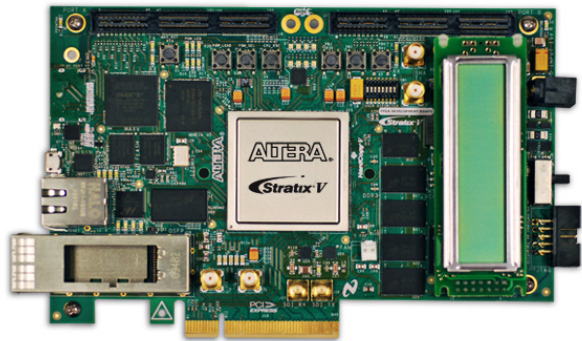
Stratix V

Altera: Transceiver Signal Integrity Development Kit, Stratix V GX Edition



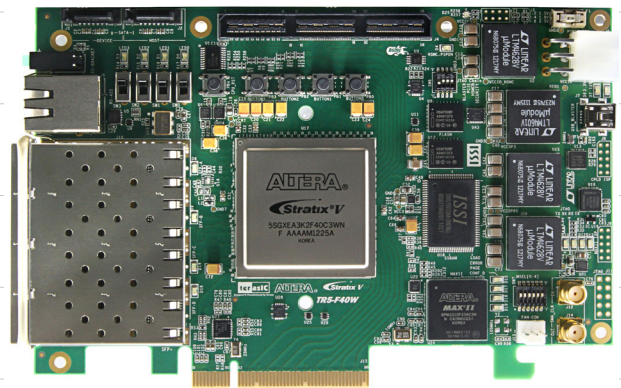
Stratix V

Altera: Transceiver Signal Integrity Development Kit, Stratix V GT Edition



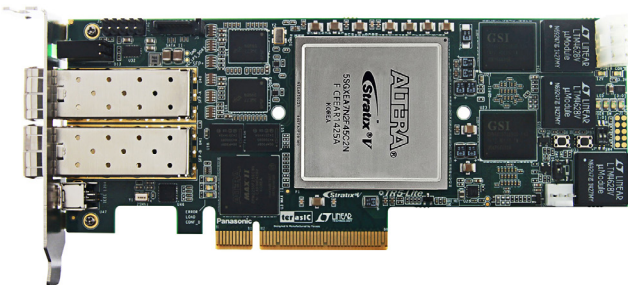
Stratix V

Altera: DSP Development Kit, Stratix V Edition



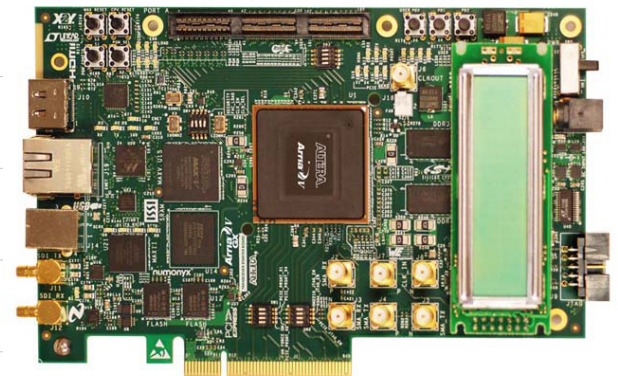
Stratix V

Terasic: TR5-F40W FPGA Development Kit



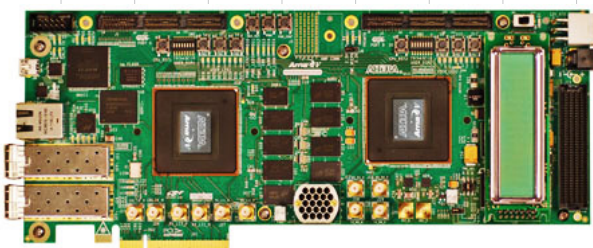
Stratix V

Terasic: TR5-Lite FPGA Development Kit



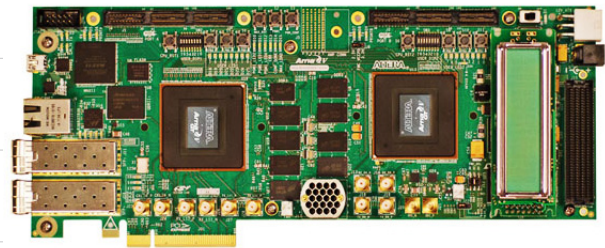
Arria V

Altera: Arria V GX FPGA Starter Kit



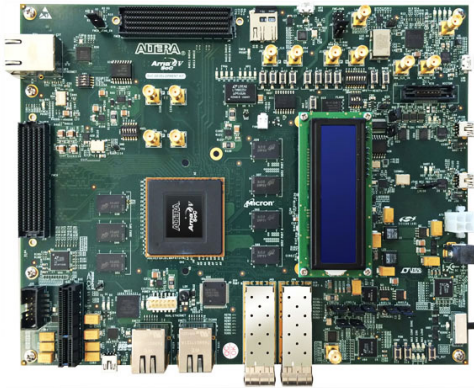
Arria V

Altera: Arria V GX FPGA Development Kit



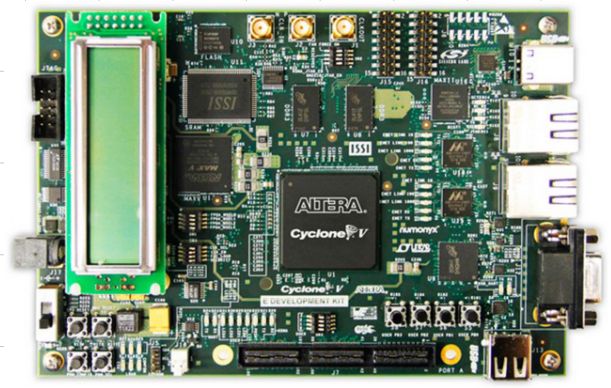
Arria V

Altera: Arria V GT FPGA Development Kit



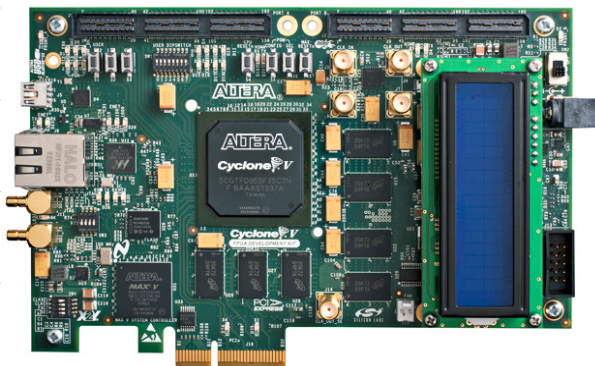
Arria V

Altera: Arria V SoC Development Kit and SoC Embedded Design Suite



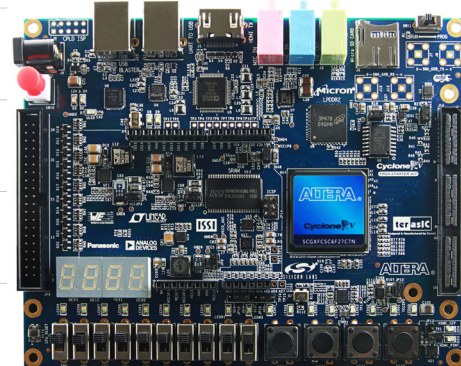
Cyclone V

Altera: Cyclone V E FPGA Development Kit



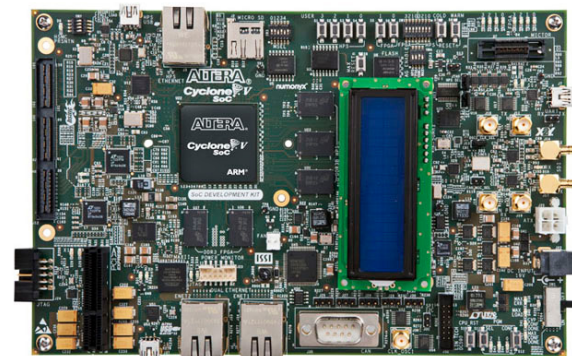
Cyclone V

Altera: Cyclone V GT FPGA Development Kit



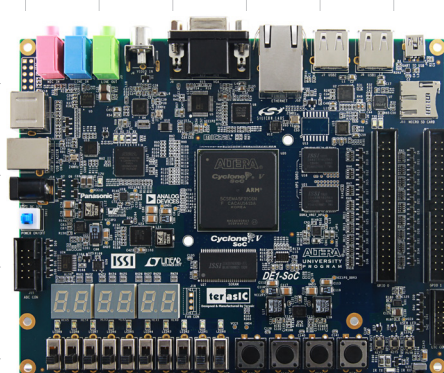
Cyclone V

Terasic: Cyclone V GX Starter Kit



Cyclone V

Altera: Cyclone V SoC Development Kit Rev C



Cyclone V

Terasic: DE1-SoC Development Kit and Education Board



Cyclone V

Arrow: SoC Kit Development Kit



Cyclone V

Macnica: Helio Base Board

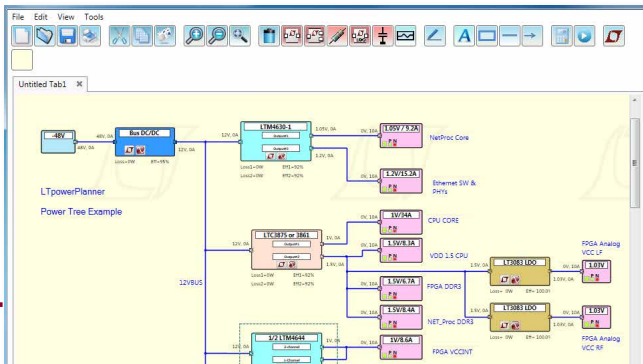
Design Support

Linear Technology provides design support tools that help you select, design and simulate Linear Technology's products. These tools shorten your design time and optimize your power supply solution before you build your prototype board.

LTpowerCAD II

LTpowerCAD® is a free download and easy-to-use power supply design tool with a user-friendly graphical user interface (GUI) and powerful design features. It helps power supply designers select a solution for given supply specifications, design power stage components, estimate regulator efficiency and power loss, and optimize supply loop stability and load transient performance. It is a fast offline tool that runs on Windows PCs, and includes a sync-release feature to ensure your program and its solution libraries are up-to-date. Once a circuit design is completed, it is easily exported to the LTspice® simulation platform. Inside the LTpowerCAD toolbox, there is also an [LTpowerPlanner](#) system architecture tool for system-level power management design and optimization.

LTpowerPlanner



System Architecture and Plan



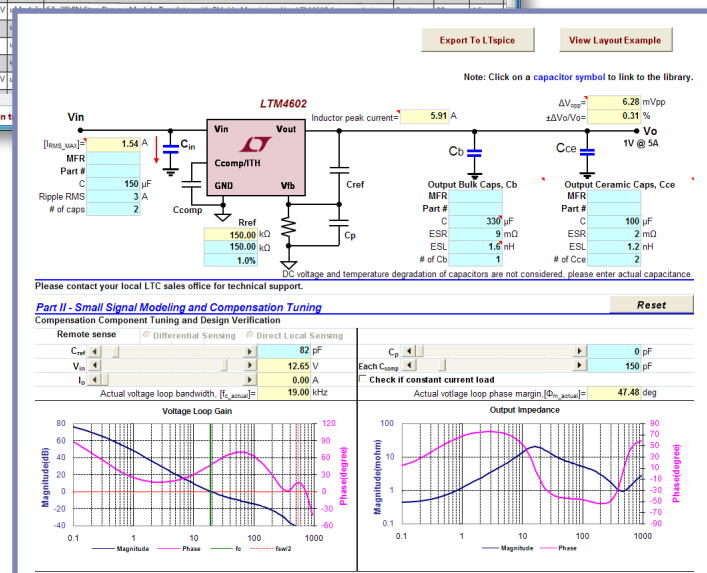
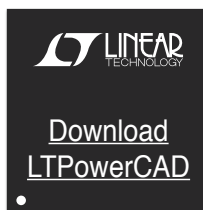
Search and Selection

LTpowerCAD

Design Tool	Website	Part Name	Type	Desc.	Topology	Max Vin	Min Vin
LTC Web	LTC Web	LTM4625	uModule	34VIN, 5A Step-Down DC/DC uModule Regulator	Buck	20	4
LTC Web	LTC Web	LTM4649	uModule	36V Single 10A Step-Down DC/DC uModule Regulator	Buck	16	4.5
LTC Web	LTC Web	LTM4603-1	uModule	6A Step-Down uModule Regulator. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4603	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4603HV	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4618	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4606	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4602	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5
LTC Web	LTC Web	LTM4602HV	uModule	6A Step-Down uModule Regulator with PLL Output Margining. Use LTM4618 for new designs.	Buck	20	4.5

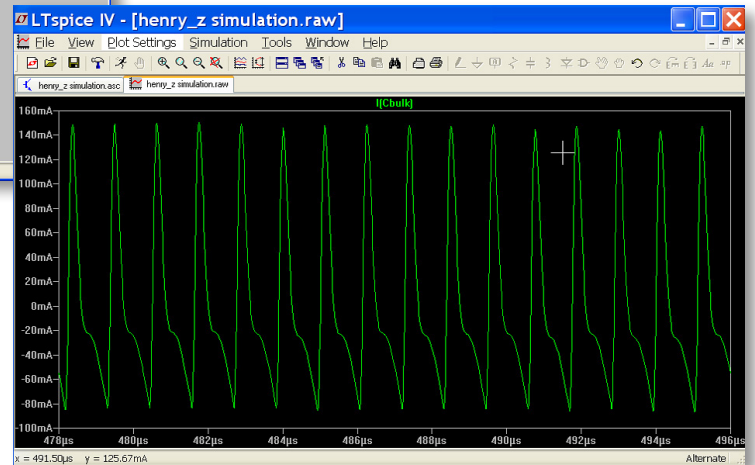
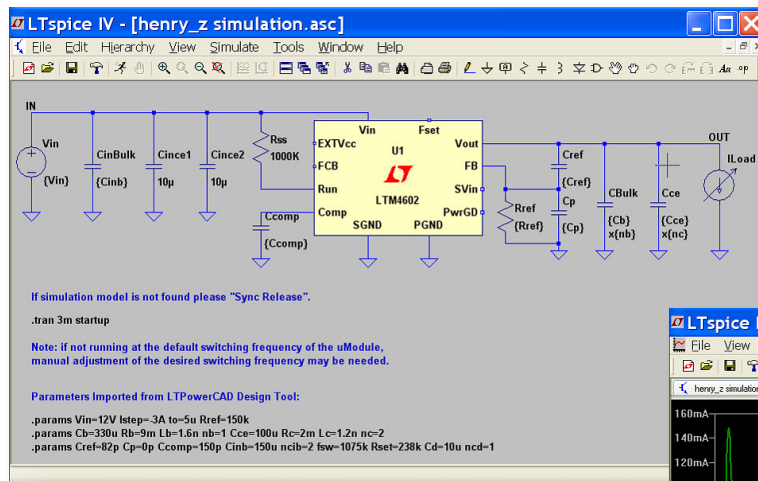


Circuit
Parameter
Design



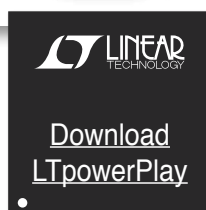
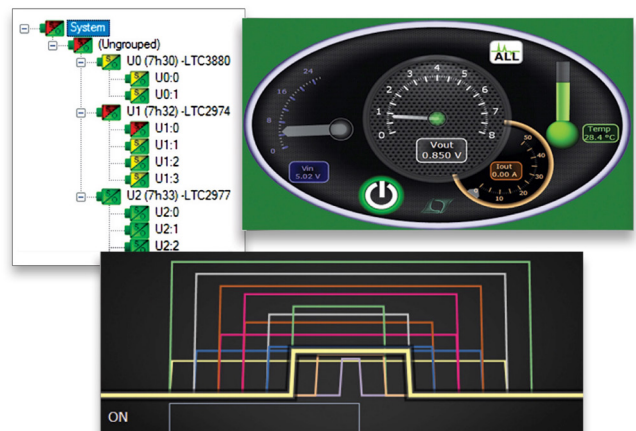
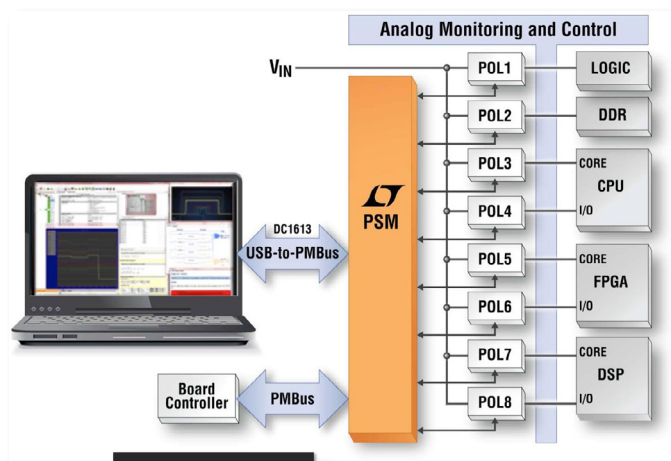
LTspice

LTspice is a free, simple and powerful circuit simulation tool with a library containing all Linear Technology products, as well as commonly used discrete passive and transistor components.



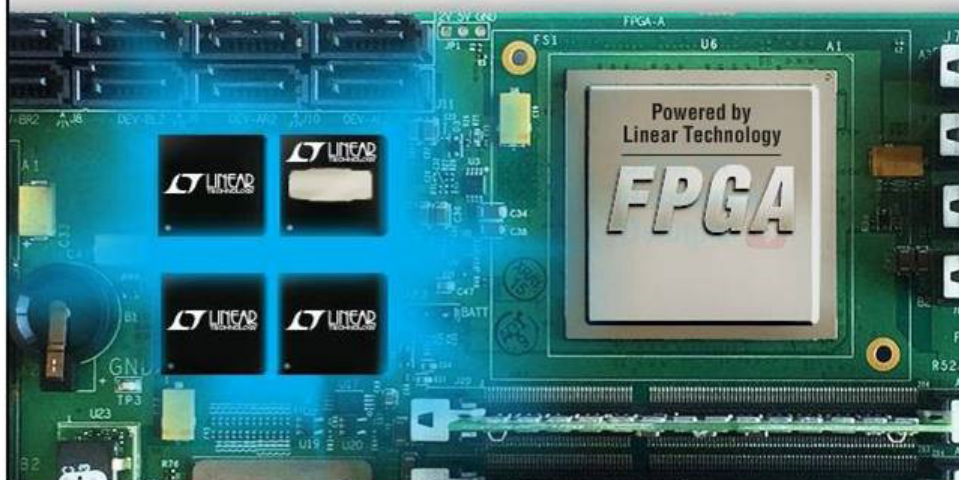
LTpowerPlay

LTpowerPlay® is a powerful and intuitive Windows-based development environment used to configure and interrogate Power System Management (PSM) devices. It can also be used in an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time.





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