Low-Dropout (LDO) Regulator

Power Component: C710, C715

Product Description

The C71x Power Component family is a customizable Low-Dropout Voltage Regulator with standard source-side regulation. Combine the C71X component with other Power Components to create a highly-integrated, custom-defined, AnDAPT AmP™ on-demand power management device.

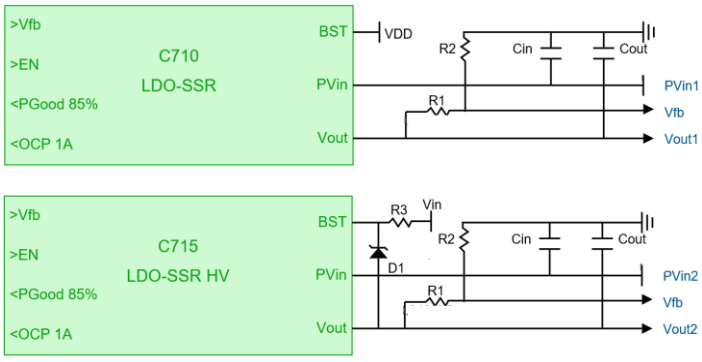
Features

- Linear, constant voltage, low-dropout regulator
- Adjustable V_{OUT} from 0.6V to 1.8V for C710
- Adjustable V_{OUT} from 1.2V to 3.3V for C715
- Maximum output current: 1A
- 1% typical line and load regulation
- Very low dropout :100 mV dropout
- Short-circuit protection (SCP)
- Protection: Overcurrent (OCP), and Over Temperature (OTP)
- Power-good and OCP flag outputs and Enable input
- Soft start/stop
- –40°C to +125°C operating junction temperature
- Utilizes one SIM element of an AmP Platform
- Additional capabilities – see I71x, P71x

Applications

- Powering server, processor, memory, storage, network switcher and router platforms
- FPGA, processor, SSD, subsystem power control & sequencing
- Imaging: CMOS Sensors, Video ASICs
- Test and Measurement
- Regulated power noise sensitive, phase-locked loops (PLLs), voltage-controlled oscillators (VCOs), and PLLs with integrated VCOs

Figure 1: C71x application schematic



Product Detail

The C71x is a 1A general purpose low-dropout (LDO) regulator. The maximum current is defined by the AmP device selected. The integrated current sense provides over-current protection (OCP) and short circuit protection.

The C710 is designed to cover the lower voltage range (0.6V to 1.8V) while the C715 is designed to cover the higher voltage range (1.2V to 3.3V). Overlap in the voltage range is provided for user convenience.

The customizable output voltage is specified by the power engineer during customization using AnDAPT's cloud-based WebAmp™ development software. The C71x component has customizable control and status pins including an enable input, an optional power-good output, and optional output flag to signal when the system triggers an overcurrent (OCP) condition.

The C71x also incorporates a soft start feature to mitigate against inrush current. Sequencing options are available when used in conjunction with the C410 customizable Sequencer, by interconnecting signals EN, PGood to provide dependencies and delays between each sequence step.

Part number	AmP Platform	IOUT Max	VOUT Max
C710	AmPxD6	1A	1.8V
C715	AmPxD6	1A	3.3V

Customizable Options

Table 1 lists the various customizable options available for the C710 Power Component.

These options are set in the WebAmp development software.

Table 1: C710 Customizable Options

Option	Units
Input voltage	V
Output voltage	V
Output Current	A
Enable OCP output to signal when overcurrent protection is triggered	On/Off
Use optional PGood output to signal "power good"	On/Off

System Characteristics

Table 2 lists the system characteristics for the C71x Power Component when implemented in an AnDAPT AmP device. "Prog" column specifies parameters that are user selectable.

Table 2: C71x System Characteristics

Parameters	Min	Typ	Max	Units
Input Drain Voltage (V_{IN}) *	V_{OUT}+ V_{DO}		17	V
Output Voltage (V_{OUT}) C710 Output Voltage (V_{OUT}) C715	0.6 1.2		1.8 3.3	V
Output Current (I_{OUT})			1	A
Dropout Voltage (V_{DO}) C710 @ V_{OUT} =1.8V I_{DS}=0.1A I_{DS}=1A		 20 100		 mV mV
Dropout Voltage (V_{LDO}) C715 @ V_{OUT} =3.3V I_{DS}=0.1A I_{DS}=1A		 20 200		 mV mV
Voltage regulation		0.5		%
Current Limit – OCP	1			A

Note: The maximum power dissipation for the C71x, (V_{IN}-V_{OUT})I_{OUT}, is limited to 1.5W

Additional Resources

- AnDAPT AmP Platform datasheet

Advanced Capabilities and Options

Table 3 lists derivatives of the C71x component with additional capabilities plus other similar components potentially suitable for this application.

Table 3: C75x Advanced Capabilities Options

Description	Part Number
Standard Pro Series version (this component)	C71x
Add external control via I^2C bus interface	I71x
Add telemetry and dynamic voltage scaling via DVS interface	P71x

Port Name Table

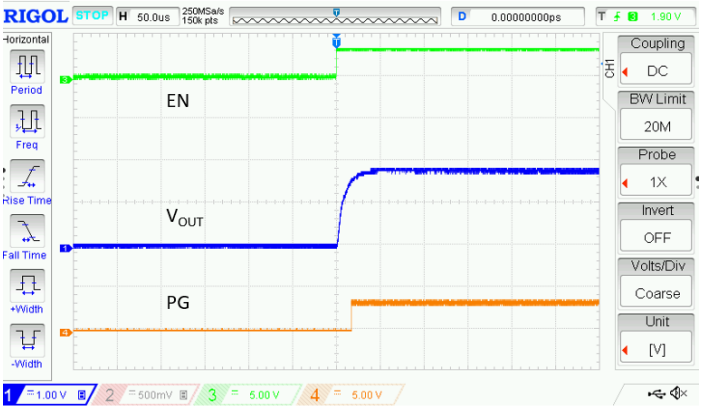
Port Name	Analog/ Digital	Input/ Output	Description
PV_{IN}	Analog	I/P	LDO Analog I/P
V_{OUT}	Analog	O/P	LDO O/P
Vfb	Analog	I/P	Feedback I/P from O/P resistor divider
BST	Analog	I/P	Bootstrap I/P. Connect to Vdd [+refer to Figure 1]
EN	Digital	I/P	Enable I/P. HIGH => LDO Enabled LOW => LDO Disabled
Pgood	Digital	O/P	Power Good indicator. HIGH => Vout > Pgood level
OCP	Digital	O/P	Over Current Indicator HIGH => O/P Current exceeds OCP level

Typical Characteristics

Unless otherwise specified: TA = 25°C

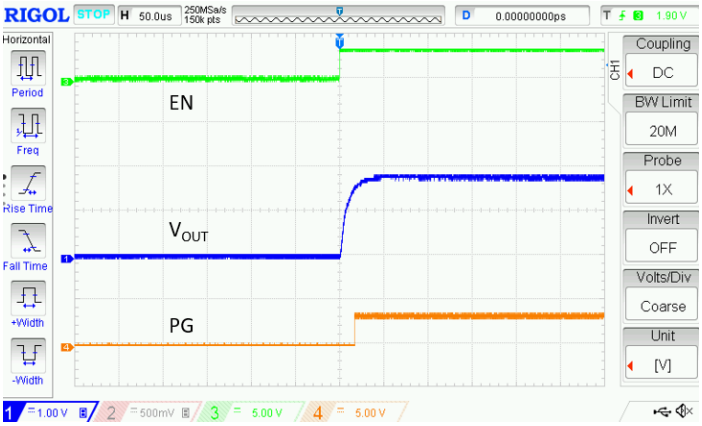
Soft Start

V_{IN} = 12V, V_{OUT} = 1.8V No load



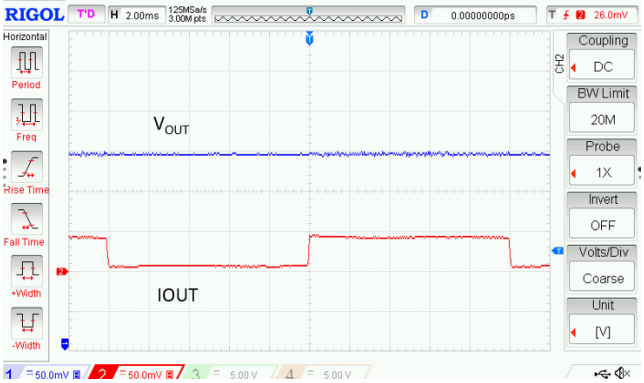
Soft Start

V_{IN} = 2V, V_{OUT} = 1.8V, 2 Ohm



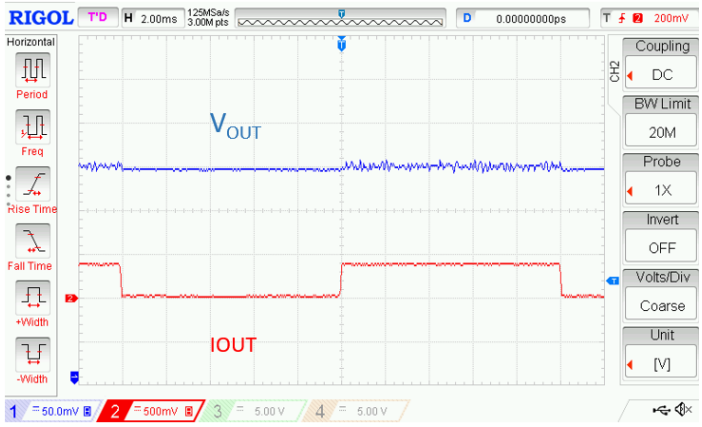
Transient Response C710

V_{IN} = 1.8V, V_{OUT} = 1.5V I_{OUT} = 0 to 100 mA Load step



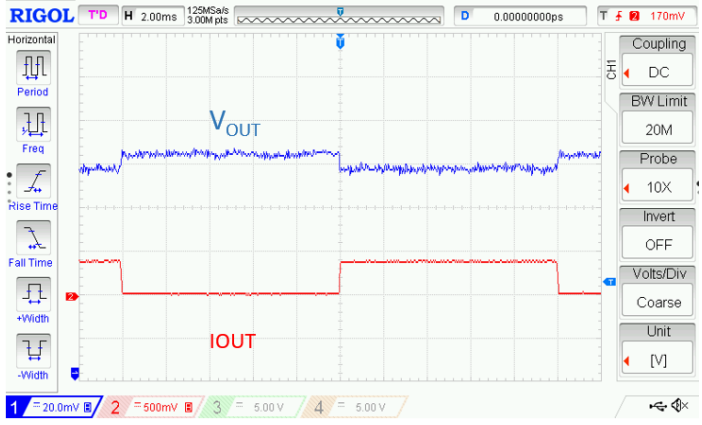
Transient Response C710

V_{IN} = 1.8V, V_{OUT} = 1.5V I_{OUT} = 0 to 0.5A Load step



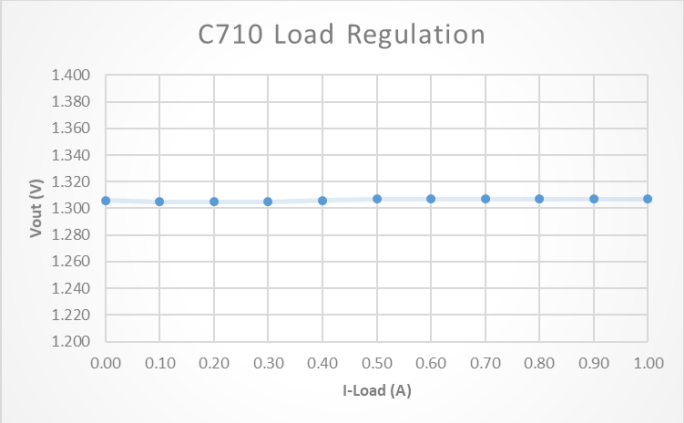
Transient Response C715

V_{IN} = 12V, V_{OUT} = 3.3V I_{OUT} = 0 to 1A Load step



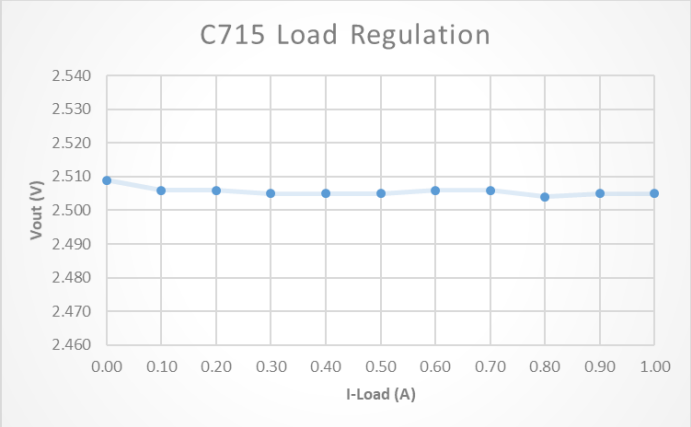
Load Regulation C710

PV_{IN} = 1.5V, V_{OUT} = 1.3V



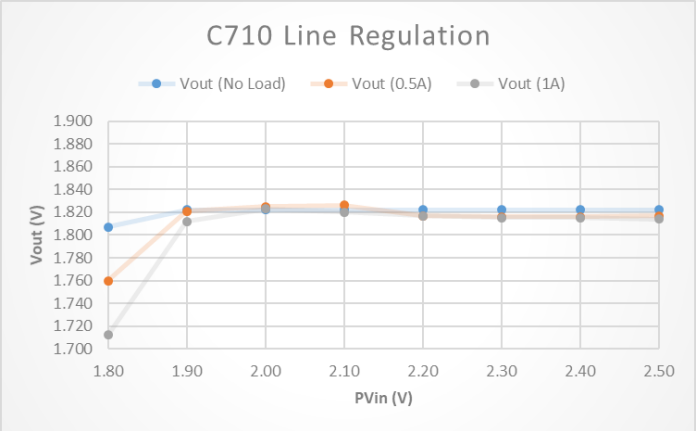
Load Regulation C715

PV_{IN} = 2.8V, V_{OUT} = 2.5V



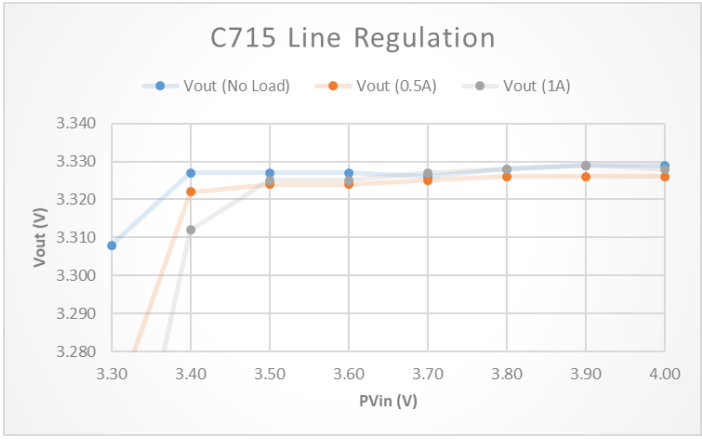
Line Regulation C710

V_{OUT} = 1.8V C_{OUT} = 69uF



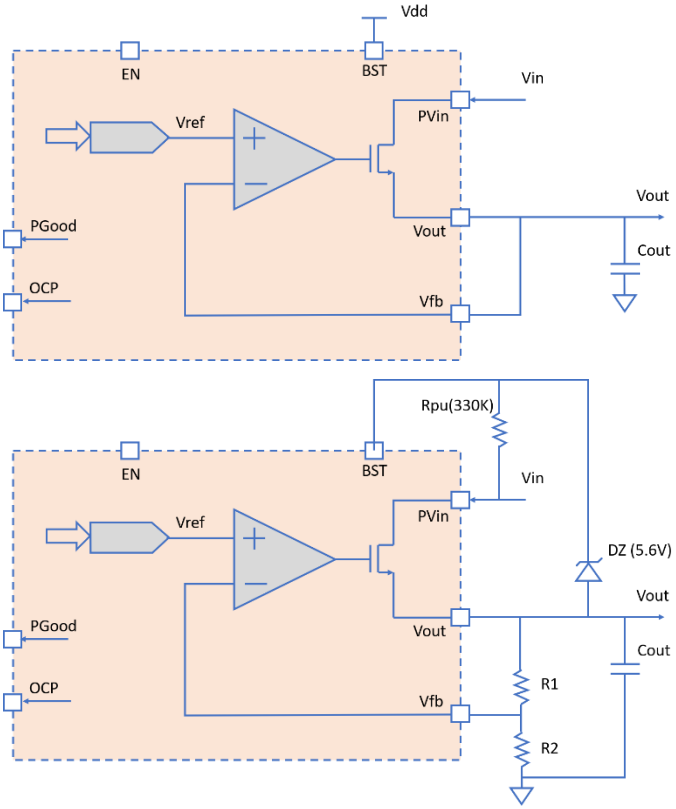
Line Regulation C715

V_{OUT} = 3.3V C_{OUT} = 69uF



Theory of Operation

The C71x is a linear voltage regulator. It consists of a reference voltage, a feedback path for the output voltage (which may use a resistor divider) to compare it to the reference, a feedback amplifier, and a series pass transistor (NMOS in the case of the C710/C715), whose voltage drop is controlled by the amplifier to maintain the output at the required value. A block diagram is shown below:



If the load current increases causing the output to drop the error voltage will increase and the amplifier output will fall. This in turn causes the voltage across the pass transistor to decrease and the output will return to its original value.

Note that a linear regulator efficiency depends on the voltage difference between input and output and is nominally given by:

100 x (V_{OUT} x I_{OUT})/(V_{IN} x I_{IN})

= 100 x V_{OUT} / V_{IN} assuming I_{OUT} = I_{IN}

with the power loss being (V_{IN} - V_{OUT}) x I_{OUT}.

The maximum power dissipation for the C71x is limited to 1.5W.

Protection Features

The C71x provides protection features including OCP and OTP. OCP is fixed at 1A. It can be enable or disable using WebAdapter interface.

Over Current Protection

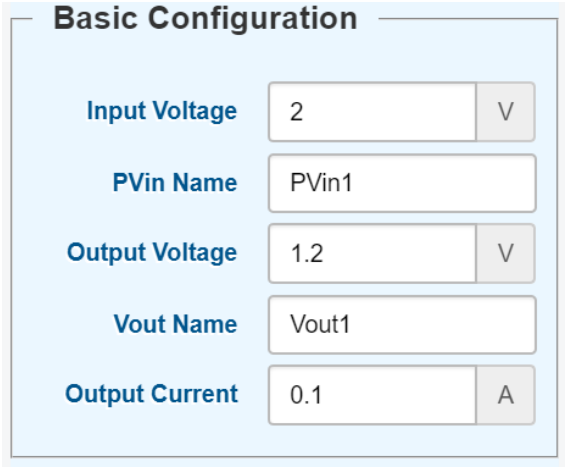
The Over Current Protection (OCP) digital port may be connected to a GPIO pin or a control component such as the C430 Fault Manager to indicate the output over current status. OCP goes high when output current, I_{OUT}, is greater than the OCP threshold. OCP goes low when output current, I_{OUT}, is less than the OCP threshold. On detection of OCP, the C71x will shut down. If OCP is triggered, the C71x will power down and PGood will go low. In that case, an EN cycling low-to-high, will restart the C71x with a new Soft Start cycle.

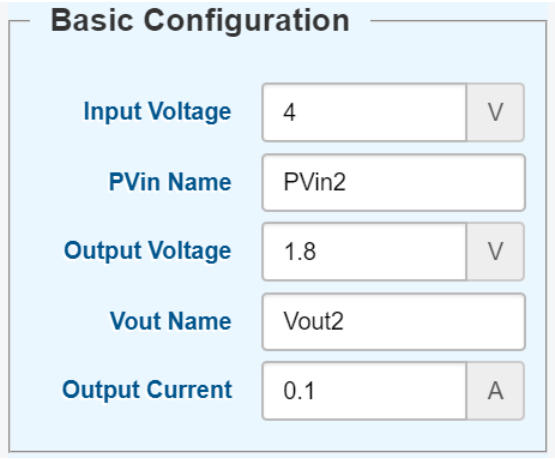
Thermal shutdown is provided to protect the regulator from excessive junction temperature. When the junction temperature reaches 125°C the device shuts down. On detection of OTP, the C71X will power down and PGood will go low. On OTP returning low, an EN cycling low-to-high, will restart the C71X with a new Soft Start cycle.

Feature Description

Basic Configuration

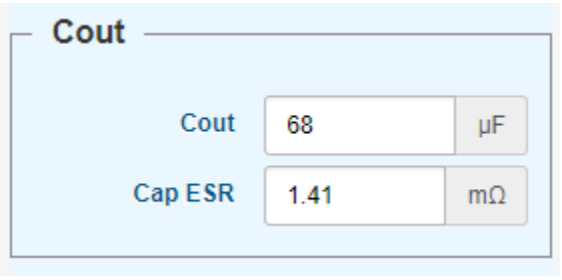
Default parameters may be changed per user requirement.





COUT Component Selection

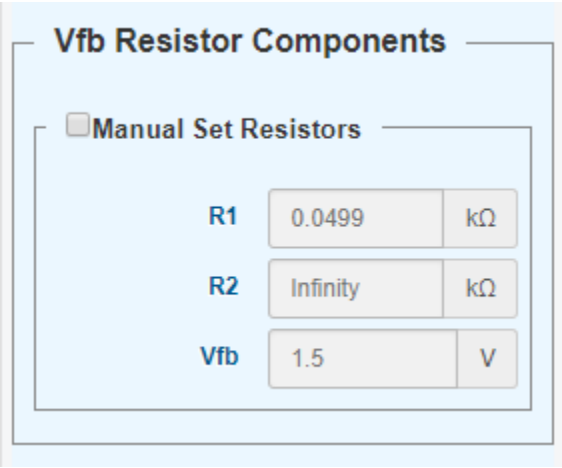
The minimum output capacitance for stability is 68 uF.



Vfb Resistor Components

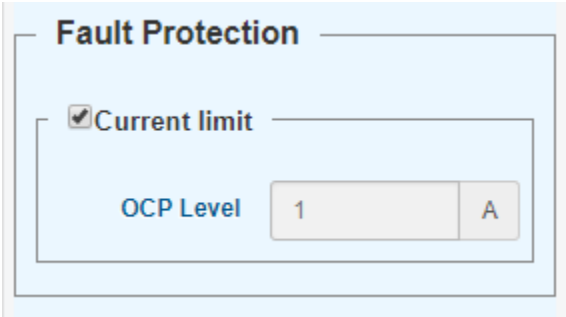
C710: Resistor divider R1 and R2 default to 49.9 Ω and open (infinity) for direct feedback of the output to the Vfb pin.

C715: Feedback divider resistors R1 and R2 are required and default to 22K and 10K



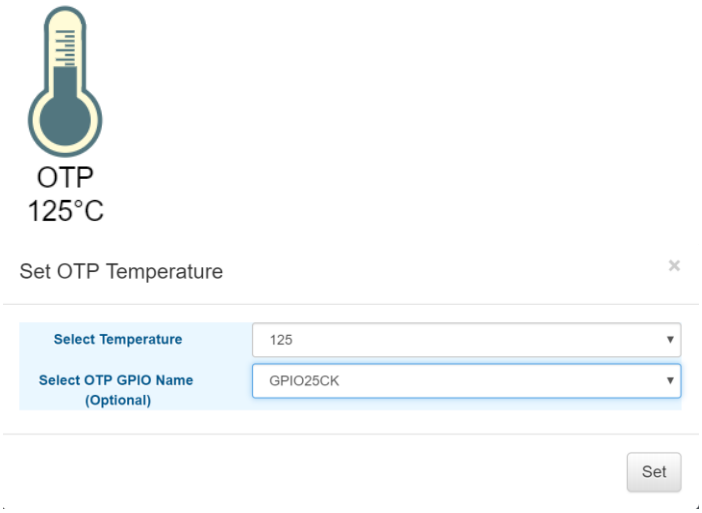
Fault Protection

Over Current Protection, OCP, indicates the output over current greater or less than OCP. Over Temperature Protection, OTP, indicates thermal shutdown has occurred. (set to 125°C).



Over Temperature Protection (OTP):

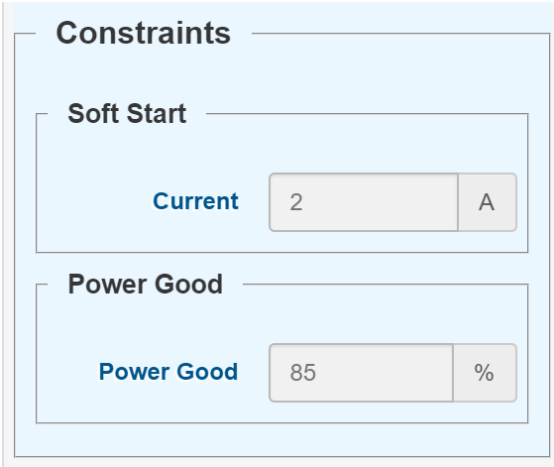
The OTP is set by default at 125 Deg C at the device level.



Constraints

Soft Start is fixed at 2A.

Power Good is fixed at 85%.



C710 Resource Usage

Circuit Stats...
- Number of AnD_Temp_Sensor 1
- Number of AnD_SIM_Linear 1
- Number of AnD_SIM_Protect 1
- Number of AnD_SIM_Sense 1
- Number of AnD_Analog_IO 6
- Number of AnD_ATC_IO 2
- Number of AnD_ATC_Comp 2
- Number of AnD_ATC_Summer 1
- Number of AnD_Nref_fix 4
- Number of AnD_DFF 2
- Number of LUT4 15

Resource Usage...
- io 2 used (Capacity 24)
- clb 2 used (Capacity 64)
- sim 1 used (Capacity 8)
- atc 1 used (Capacity 6)
- corner 3 used (Capacity 4)
- ptg 1 used (Capacity 2)
- uLogic 15 used (Capacity 512)

Components Stats...
- $techmap\OTP_fuse_module
  - AnD_DFF 2
- OTP_fuse_module
  - AnD_ATC_Comp 1
  - AnD_Nref_fix 1
- component_1
  - AnD_ATC_Comp 1
  - AnD_ATC_Summer 1
  - AnD_Nref_fix 3
  - AnD_SIM_Linear 1
  - AnD_SIM_Protect 1
  - AnD_SIM_Sense 1

C715 Resource Usage

Circuit Stats...
- Number of AnD_Temp_Sensor 1
- Number of AnD_SIM_Linear 1
- Number of AnD_SIM_Protect 1
- Number of AnD_SIM_Sense 1
- Number of AnD_Analog_IO 6
- Number of AnD_ATC_IO 2
- Number of AnD_ATC_Comp 2
- Number of AnD_ATC_Summer 1
- Number of AnD_Nref_fix 4
- Number of AnD_DFF 2
- Number of LUT4 15

Resource Usage...
- io 2 used (Capacity 24)
- clb 2 used (Capacity 64)
- sim 1 used (Capacity 8)
- atc 2 used (Capacity 6)
- corner 3 used (Capacity 4)
- uLogic 15 used (Capacity 512)

Components Stats...
- $techmap\OTP_fuse_module
  - AnD_DFF 2
- OTP_fuse_module
  - AnD_ATC_Comp 1
  - AnD_Nref_fix 1
- component_2
  - AnD_ATC_Comp 1
  - AnD_ATC_Summer 1
  - AnD_Nref_fix 3
  - AnD_SIM_Linear 1
  - AnD_SIM_Protect 1
  - AnD_SIM_Sense 1

Additional Resources

- AnDAPT AmP Platform datasheet

Revision History

Date	Revision
11/27/2018	Preliminary release

AnDAPT

On-Demand Power Management

www.AnDAPT.com

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