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Low-Dropout (LDO) Regulator Power Component: C710_B

Product Description

The C710_B Power Component is a customizable Low-Dropout Voltage Regulator with standard source-side regulation. Combine the C710_B 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 VOUT from 0.6V to 3.3V
- Maximum output current: 1A with "Internal" feedback and 3A with "External" feedback
- 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/stap
- Soft start/stop
- -40°C to +125°C operating junction temperature
- Utilizes one SIM element of an AmP Platform
- Additional capabilities see I710, P710

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: C710_B application schematic Internal Feedback



External Feedback



Product Detail

The C710_B is a 3A 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_B is designed to cover the voltage range (0.6V to 3.3V).

The customizable output voltage is specified by the power engineer during customization using AnDAPT's cloud-based WebAmp[™] development software. The C710_B 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 C710_B also incorporates a soft start feature to mitigate against inrush current. Sequencing options are available when used in conjunction with the C420 customizable Sequencer, by interconnecting signals EN, PGood to provide dependencies and delays between each sequence step.

The C710_B has a minimum load requirement of 100uA

Part number	AmP Platform	IOUT Max	VOUT Max
C710 (Internal f/b)	AmPxD6	1A	3.3V
C710 (External f/b)	AmPxD6	3A	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	А
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 C710_B Power Component when implemented in an AnDAPT AmP device. "Prog" column specifies parameters that are user selectable.

Table 2: C710_B System Characteristics

Parameters	Min	Тур	Max	Units
Input Drain Voltage (V _{IN}) *	V _{out} + Vdo		17	V
Output Voltage (VOUT) C710	0.6		3.3	V
Output Current (I _{OUT}) Internal F/B External B/B			1 3	A A
Dropout Voltage (V _{DO}) C710 @ V _{OUT} =1.8V I _{DS} =0.1A		20		mV
I _{DS} =1A		100		mV
Voltage regulation		0.5		%
Current Limit – OCP	1			А

*Note: The maximum power dissipation for the C710_B, (V_{IN}-V_{OUT})*I_{OUT}, is limited to 1.5W

Advanced Capabilities and Options

<u>Table 3</u> lists derivatives of the C710_B component with additional capabilities plus other similar components potentially suitable for this application.

Table 3: C75x Advanced	Capabilities	Options
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	Part
Description	Number
Standard Pro Series version (this component)	C710_B
Add external control via I ² C bus interface	I710
Add telemetry and dynamic voltage scaling via DVS interface	P710

Port Name Table

Port Name	Analog/ Digital	Input/ Output	Description
PVIN	Analog	I/P	LDO Analog I/P
Vout	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. This pin should be left floating. [+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





Soft Start

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



Transient Response C710_B

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



Transient Response C710_B

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



Transient Response C710_B VIN = 12V, VOUT = 3.3V IOUT = 0 to 1A Load step



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Low-Dropout (LDO) Regulator

Load Regulation C710_B Vout = 3.3V Vout, Cout = 10µF



Load Regulation C710_B Vout = 3.3V Vout, Cout = 47µF



Line Regulation C710_B $V_{OUT} = 3.3V$ Vout, Cout = 10 μ F



Line Regulation C710_B Vout = 3.3V Vout, Cout = 47µF



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Theory of Operation

The C710_B 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_B), whose voltage drop is controlled by the amplifier to maintain the output at the required value.

The C710_B offers two configurations, Internal feedback and External feedback. External feedback configuration requires the use of a Vfb pin to sense the Vout voltage and offers the best load regulation performance at ~4mV/A as well as operating up to 3A output current while the Internal feedback configuration eliminates the need for a Vfb pin but provides lower load regulation at ~15mV/A and operates up to 1A output current. Block diagrams are shown below:

Internal Feedback



External Feedback



External Feedback with resistor divider



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 (Vout x Iout)/(Vin x Iin)

= 100 x Vout / VIN assuming Iout = IIN

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

The maximum power dissipation for the C710_B is limited to 1.5W.

Protection Features

The C710_B 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 Digital Block Gate to indicate the output over current status. OCP goes high when output current, IouT, is greater than the OCP threshold. OCP goes low when output current, IoUT, is less than the OCP threshold. On detection of OCP, the C710_B will shut down. If OCP is triggered, the C710_B will power down and PGood will go low. In that case, an EN cycling low-to-high, will restart the C710_B 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 C710_B will power down and PGood will go low. On OTP returning low, an EN cycling low-to-high, will restart the C710_B with a new Soft Start cycle.

Feature Description

Basic Configuration

Default parameters may be changed per user requirement.

 Basic Configuration 		
PVIN Voltage	2	V
PVin Name	PVin1	
Output Voltage	1	V
Vout Name Vout1		
Output Current	0.1	А
Min Load required = 0.2mA		

COUT Component Selection

The minimum output capacitance for stability is 10 $\mu F.$ for internal feedback and 47 μF for internal feedback.

Cout		
Cout	10	μF
Cap ESR	1.41	mΩ

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.

Vfb Resistor Components				
Manual Set Resistors				
R1	0.0499	kΩ		
R2	DNI	kΩ		
Voutsense 1 V				

Fault Protection

Over Current Protection, OCP, indicates the output over current greater or less than OCP.

Fault Protection			
Current limit			
OCP Level 0.6 A			

Over Temperature Protection (OTP):

Over Temperature Protection, OTP, indicates thermal shutdown has occurred. The OTP is set by default at 125 Deg C at the device level, routable to a GPIO.

	Set OTP Temperature		×
\frown			
	Select Temperature	125	~
	Select OTP GPIO Name (Optional)	GPIO13	~
OTP 125°C			Set

Constraints, Internal Feedback

- Constraints -	
Vout Sense	Internal V
Soft Start	
┌ ✓Soft Start En	able
Current	0.1 A
Power Good	
Power Good	85 %

Constraints, Internal Feedback

─ Constraints		
Vout Sense	External ~	
Soft Start		
Soft Start Enable		
Current	0.1 A	
Power Good	85 %	

Power Component Version Table

Power Component Name	Description
C710_B_1_1	Reduced quiescent current
C710_B_1_0	First Version

Circuit S	tats		
1	Number	of AnD_Temp_Sensor	1
1	Number	of AnD_SIM_Linear	1
1	Number	of AnD_SIM_Protect	1
1	Number	of AnD_SIM_Sense	1
1	Number	of AnD_Analog_IO	6
1	Number	of AnD_ATC_IO	3
1	Number	of AnD_ATC_Comp	3
1	Number	of AnD_Nref_fix	4
1	Number	of AnD_PTG_Phase_(Count 1
1	Number	of AnD_PTG_GBUF	1
1	Number	of AnD_PTG_OSC	1
1	Number	of AnD_DFFN 7	
I	Number	of AnD_DFF 3	
I	Number	of LUT4 25	
Resourc	e Usage		
i	io	3 used (Capacity 24	.)
(clb	6 used (Capacity 64	.)
5	sim	1 used (Capacity 8))
á	atc	2 used (Capacity 6))
(corner	3 used (Capacity 4))
ł	ptg	1 used (Capacity 2)	
ι	uLogic	25 used (Capacity 51	2)
Compon	ents Sta	ts	
9	\$techma	p\otp_fuse_module	
	1	AnD_DFF 3	
	1	AnD_DFFN 7	
(compone	ent 1	
		AnD ATC Comp	2
		AnD Nref fix 3	
		AnD SIM Linear	1
		AnD SIM Protect	1
	1	AnD_SIM_Sense	1
ć	oto fuse	module	
	/	AnD ATC Comp	1
		AnD_Nref_fix 1	

C710_B Internal F/B Resource Usage C710_B External F/B 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	4		
Number of AnD_ATC_Comp	3		
Number of AnD_AIC_Summer	1		
Number of AnD_Nret_Tix	4		
Number of AnD_PTG_Phase_Co	unt 1		
Number of AnD_PTG_GBUF	1		
Number of AnD_PTG_03C	I		
Number of AnD_DEF 3			
Number of LUTA 26			
Resource Usage			
io 4 used (Capacity 24)			
clb 6 used (Capacity 64)			
sim 1 used (Capacity 8)			
atc 2 used (Capacity 6)			
corner 3 used (Capacity 4)			
ptg 1 used (Capacity 2)			
uLogic 26 used (Capacity 512))		
Components Stats			
\$techmap\otp_fuse_module			
AnD_DFF 3			
AnD_DFFN 7			
component_1	_		
AnD_ATC_Comp 2	2		
AnD_AIC_Summer 7	1		
AnD_Nref_fix 3			
AnD_SIM_Linear	1		
AnD_SIM_Protect	1		
AND_SIM_Sense	I		
oto fuse module			
	1		

AnD_ATC_Comp AnD_Nref_fix 1

Additional Resources

AnDAPT AmP Platform datasheet

Revision History

Date	Revision
06/19/2020	Platform B, revision B release
07/05/2019	Added C710_A_2_0 conditions for Load Regulation and Constraints
11/27/2018	Preliminary release



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