

LTC2984DSM

LTC2984 Demo Software Manual

DESCRIPTION

The LTC[®]2984 demo software is designed to help configure, program and run the LTC2984. It can configure the LTC2984, save the configuration, check for configuration errors, run the LTC2984, output the conversion results into a text file, and create Linduino-ready C code based on the configuration. The software can be used by itself, or used in conjunction with the DC2399 demo circuit.

The software can be used by itself, or used in conjunction with the DC2399 demo circuit. For more information about this circuit, please see http://www.linear.com/demo/DC2420A

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INSTALLING THE PROGRAM

The LTC2984 demo software can be installed either through QuikEval™ or manually.

QuikEval provides a single interface that installs and launches the appropriate Linear Technology demo software based on the hardware connected to the computer. However, QuikEval requires connected demo hardware (DC2399) to install or run.

A manual install and/or launch, by contrast, works with or without any of the accompanying demo hardware.

To install through QuikEval, follow the steps below:

- 1. Obtain the DC2399 demo circuit, one sensor-specific demo circuit (DC2210, DC2211, DC2212, DC2213 or DC2214), and a DC2026 Linduino demo board.
- 2. Before connecting the hardware to the computer, install the latest version of the QuikEval software. This can be downloaded at www.linear.com/software.
- 3. Connect the hardware together. Connect the DC2399 to the DC2026 using the supplied 14-conductor ribbon cable. Connect the sensor-specific demo circuit directly to the DC2399 demo board through the 40-pin connector. Connect the DC2026 to the computer using a standard USB cable.
- 4. Launch the QuikEval software. The LTC2984 demonstration software will install and launch automatically.

To launch through QuikEval, repeat steps 3 to 4 above.

To install manually, follow the steps below.

- 1. Download the file "InstallLTC2984.zip" from http://ltspice.linear.com/software/InstallLTC2984.zip.
- Right click the file and choose "Extract All." Choose a suitable location for the extraction folder, and check the "Show extracted files when complete" check box. Click "Extract" to extract the files.
- 3. In the extracted folder, double-click the file ins2984.msi and follow the prompts to install the LTC2984 QuikEval module.
- 4. In the extracted folder, double-click the file CDM20824_ Setup.exe to install the USB drivers. (Note: If you are sure that you have up-to-date FTDI drivers, you can skip this step.)

To launch manually, from the Start menu, select "Linear Technology" \rightarrow "LTC2984" \rightarrow "LTC2984."

Regardless of the installation method, the user can later launch the program manually or, if installed, through QuikEval.



QUICK START PROCEDURE

When the program is started, the screen in Figure 1 appears.

There are menus for Configuration, Evaluation, C code generation, and Help. Moving the mouse pointer over the

toolbar buttons will show a mouseover box describing the button's function.

There is also a log window, which can give useful information (particularly with unexpected events).

🚺 LTC2984 Demo - ch_default.cfg					
Configuration Evaluate C code	Setting	s Help			
			LTC	2984 TES	STBENCH
		TECHNOLOGY			
P	Ch1	Sensor	Edit Out (uV, ohm)	Out (Deg C)	Status byte
-	Ch 2				
-	Ch 3				
	Ch 4				
	Ch 5				
-	Ch 6	-			
	Ch 7	-			
-	Ch 8				
-	Ch 9				
	Ch 10	-			
	Ch 11				
-	Ch 12				
	Ch 13				
	Ch 14	-			
	Ch 15				
	Ch 16	-			
	Ch 17	-			
	Ch 18	-			
	Ch 19	-			
	Ch 20	-			
	L				

Figure 1. Main Screen



The user can either create a new configuration or load an existing configuration.

Creating a New Configuration

In this example, the LTC2984 will be configured for a thermocouple on Channel 3 with a RTD PT-100 cold junction on Channel 9, using a sense resistor on Channel 7. When this example is finished, the configuration should look like Figure 2.

Additionally, the type K thermocouple on Channel 3 will use the LTC2984's open circuit checking feature, with an open circuit detect current of 100 μ A. The RTD PT-100 on Channel 9 will use an American standard. It will also use a 4-wire configuration, without rotation or sharing, and will use 100 μ A excitation current. The sense resistor for this specific daughter board was measured precisely at 1999.1 Ω .

To set up this configuration, first add a Type K thermocouple on Channel 3. Click on the Sensor box on Channel 3, and choose the Type K thermocouple, shown in Figure 3.

[Us	e Sensor	Edit Out (uV, ohm)	Out (deg C)	Status byte
	Ch 1	-			
□-	Ch 2	-			
Cold jn:	Ch 3 🔽	Type K Thermocouple			
	Ch 4	•			
	Ch 5	-			
	Ch 6	-			
┲╌╴╴	Ch 7	Sense Resistor			
╞╼╾	Ch 8	-			
≥ [≴] ⊡-	Ch 9 🔽	RTD PT-100			

Figure 2. Desired Configuration, After Setup, with a Thermocouple and RTD Cold Junction



After selecting the thermocouple, the demo software will draw a thermocouple on Channel 3, shown in Figure 4. This shows how the thermocouple should be wired to the LTC2984 (for thermocouples, protection resistors and filter capacitors can also be added). There is also a

checkbox under the "Use" column. If it is checked, the demo software will make a measurement on this channel while it is running.

To remove this device, select the "-" choice (top selection in Figure 3).

🚺 LTC2984 Demo -	ch_default.cfg)				- • ×
Configuration	Evaluate	C code Settin	ngs Help			
	 Section 1 	😧 🕨				
					0001 TEC	TDENCU
				LIU	2904 IEC	
			TECHNOLOGY			
		Us	e Sensor	Edit Out (uV, ohm)	Out (Deg C)	Status byte
		Ch 1	-	-		
		Ch 2		•		
		Ch 2				
		Ch 4	- Type I Thermocouple			
		Ch 5	Type K Thermocouple			
		Che	Type E Thermocouple			
		Cho	Type R Thermocouple			
		Ch 7	Type S Thermocouple			
		Ch 8	Type T Thermocouple			
			Custom Thermocouple			
		Ch 9	RTD PT-10			
		Ch 10	RTD PT-50 RTD PT-100			
		Ch 11	RTD PT-200			
			RTD PT-500			
		Ch 12	RTD PT-1000 375			
		Ch 13	RTD NI-120			
		Ch 14	RTD Custom			
		Cn 14	Thermistor 44004 2.252K@25C			
		Ch 15	Thermistor 44007 5K@25C			
		Ch 16	Thermistor 44006 10K@25C Thermistor 44008 30K@25C			
			Thermistor YSI-400 2.252K@25C			
		Cn1/	Thermistor 1003K 1K@25C			
		Ch 18	Thermistor Custom Steinhart-Ha Thermistor Custom Table	nt 🛛		
		Ch 19	Off-Chip Diode			
			Sense Resistor			
		Ch 20	-	- Z		

Figure 3. Selecting the Type K Thermocouple



Figure 4. Display After Thermocouple Is Selected





To configure the thermocouple, click the corresponding "Edit" button to the right on Channel 3. The dialog in Figure 5 will appear. Change the choices to match Figure 5.

In this case, the cold junction sensor is on Channel 9, the thermocouple measurement is single-ended, open-circuit detection is generated by the LTC2984, and the open detect current is 100μ A.

When satisfied with the changes, click "Accept Changes."

Note that the channel assignment data, shown at the bottom of the window, has updated. This channel assignment is the 32-bit word that is sent into the memory location for the given channel in order to configure it. This is shown in Figure 6.

Close this dialog box.

Ch 3 Thermocouple Configuration	on		
	Value	Change to	Accept
tc - cold junction ch	-	Ch 9 🔽	
tc - differential?	No	No 💌	Cancel
tc - open ckt detect?	No	Yes 🗸	
tc - open ckt detect current	10uA	100uA 🗸	
Channel assignment	000100000010	000000000000000000000000000000000000000	

Fig. 5: Changing the Thermocouple Configuration

🚺 Ch 3 Thermocouple Configurati	on		
	Value	Change to	Accept
tc - cold junction ch	Ch 9	Ch 9 🔽	
tc - differential?	No	No 💌	Cancel
tc - open ckt detect?	Yes	Yes 💌	
tc - open ckt detect current	100uA	100uA 💌	
Channel assignment	000100100111	010000000000000000000000000000000000000	

Figure 6. Configuration Screen After "Accept Changes" Button Is Pressed

Next, add a cold junction sensor on Channel 9. Similar to how the thermocouple was selected, go to the Sensor

box on Channel 9, and select the RTD PT-100. The screen should now look like Figure 7.

LTC2984 Demo - ch_default.cfg*					- - X
Configuration Evaluate C code	Setting	s Help			
🗌 🖉 🖬 🚂 🖌 😣 🔕 🚽	-				
			LTC2	2984 TES	TBENCH
		TECHNOLOGY			
_	Use	Sensor	Edit Out (uV, ohm)	Out (Deg C)	Status byte
	Chi	•			
	-Ch 2	- •			
	-Ch 3 🔽	Type K Thermocouple 🗸			
	Ch 4				
	Ch 5	÷ •			
-	Ch 6	- •			
-	Ch 7	- · · · · · · · · · · · · · · · · · · ·			
5-0-	Ch 8				
<u></u> -₽-	Ch 9 🔽	RTD PT-100			
	Ch 10				
-	Ch 11	· ·			
-	Ch 12	- •			
-	Ch 13				
-	Ch 14	- •			
-	Ch 15				
-	Ch 16				
-	Ch 17				
-	Ch 18				
-	Ch 19				
-	Ch 20	- •			

Figure 7. Software After RTD Is Selected on Channel 9





To configure the RTD, click the Edit button on Channel 9, and fill the form out as shown in Figure 8. Then click Accept Changes.

The main screen should match Figure 9. The RTD is now grounded on Channel 9 (which happens when there is no rotation or sharing).

Close this dialog box.

Ch 9 RTD Configuration			
	Value	Change to	Accept
rtd - rsense channel	Ch 7	Ch 7 💌	
rtd - num wires	4-Wire	4-Wire	Cancel
rtd - excitation mode	No rotation/no	No rotation/no sharing 🐱	
rtd - excitation current	100uA	100uA 🗸	
rtd - standard	American	American 🐱	
Channel assignment	011000011110	000101010000000000000000000000000000000	

Figure 8. Configuring the RTD on Channel 9

	Use	Sensor	Edit Out (uV, ohm)	Out (deg C)	Status byte
-	Ch 1	- 🗸			
-	Ch 2	- 🗸			
Cold jn:	-Ch 3 🗹	Type K Thermocouple 🗸 🗸			
	-Ch 4	-			
-	Ch 5	- 🗸			
	Ch 6	-			
<u>⊢</u> ∎-	Ch 7	- 🗸			
	Ch 8	- 🗸			
∼ ≥ ∳⊡-	Ch 9 🗹	RTD PT-100			
₽-	Ch 10	- 🗸			

Figure 9. Main Screen After RTD Configuration Was Changed

Setting Global Parameters

As mentioned in the LTC2984 data sheet, the temperature unit, rejection frequency and delay between individual conversions are adjustable. To change these parameters, in the menu bar, go to Configuration \rightarrow Set global parameters. The dialog box in Figure 10 should appear.

The default values are fine here, so close this box.

Checking The Configuration

To check the configuration, either go to Evaluate \rightarrow Check configuration in the menu bar, or press the check mark button in the toolbar. The demo software then looks like Figure 11:

LTC2983 parameters	
Temperature unit	Deg C 👻
Rejection frequency	50/60 Hz 🗸
Extra delay between conversions (hundreds of us)	0
OK Cancel	



Use	Sensor	Edit Out (uV, ohm)	Out (deg C)	Status byte
Ch 1	- •			
Ch 2	-			
ch 3 🗹	Type K Thermocouple			
Ch 4	-			
□ – <mark>c</mark> h 5	- Configuration warnin	5		
	- A sense resisto	or needs to be on chan	inel 7	
₽ Ch 7	- (ж		
 Ch8	-			
<mark>`∑[£]⊡-</mark> ch9 ⊻	RTD PT-100			
			1	

Figure 11. Main Screen After Running the Configuration Checker



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The demo software includes an extensive configuration checker, which in this case shows that a sense resistor was never added on Channel 7. To add the sense resistor, select the sense resistor from the Sensor box. Click the edit button and enter the value of the sense resistor (1999.1 in this example). The resulting dialog box should look like Figure 12.

The software rounded 1999.1 to the closest value that can be represented in the LTC2984's 27-bit format.

Close this dialog and check the configuration again – there should be a message that no errors were found.

Save Configuration

To save this configuration, go to Configuration \rightarrow Save, or press the save button, and pick a name for the file (demo_manual1.cfg). The configuration can now be opened from the menu by selecting configuration \rightarrow open.

The configuration should look as shown in Figure 13.

Every channel with a device is checked, except for the sense resistor. Every sensor that is checked will be measured, but since the sense resistor is part of the RTD measurement and is not measured separately, there is no option to check it.

Ch 7 Sense Resistor Configuration	
Value Change to sense resistor - value 1999,09960938 1999,09960938	Accept Changes
Channel assignment 11101000000111110011110001100110	

Figure 12. Changing the Sense Resistance

	Use	Sensor	E	dit Out (uV, ohm)	Out (deg C)	Status byte
	Ch 1	-	•			
	Ch 2	-	•			
Cold jn:	Ch 3 🗹	Type K Thermocouple	•			
	Ch 4	-	•			
	Ch 5	-	•			
₽	Ch 6	-	•			
⋛─₽	Ch 7	Sense Resistor	•			
╞╌┹	Ch 8	-	•			
∼ _₹ ₽	Ch9 🗹	RTD PT-100	•			

Figure 13. Final Configuration



Load an Existing Configuration

A number of example configurations, from both the data sheet and from the demo boards, are also available. For example, to load the configuration for the DC2212 demo

board, from the menubar select Configuration \rightarrow Load Example \rightarrow Demo Board \rightarrow DC2212_THERMOCOUPLE_BOARD. The circuit in Figure 14 will load.

Configuration Evaluate C cod					
	e Setting	s Help			
▋▋▋▌▝▝₿▝₿	Ľ		LT	C2984 TE	STBENCH
	Use	Sensor	Edit Out (uV, ohn	n) Out (Deg C)	Status byte
Cold jn: Ch 2	Ch1 🔽	Type J Thermocouple	-		
÷4	- Ch 2 🔽	Off-Chip Diode	- 🛛		
Cold jn:	- Ch 3 🔽	Type K Thermocouple	- 🛛		
€-K	Ch 4 🔽	Off-Chip Diode	-		
√	- Ch 5 🔽	Type J Thermocouple	-		
ج	Ch 6	-	- 🛛		
r -	Ch 7	Sense Resistor	- 🛛		
	Ch 8	-	- 🛛		
- \$	- Ch 9 🔽	RTD PT-100	-		
₹ √	- Ch 10 🔽	Type J Thermocouple	-		
	Ch 11		- 🛛		
-	- Ch 12	-	-		
	Ch 13	-	-		
-	Ch 14	-	-		
-	- Ch 15	-	-		
	Ch 16	-	-		
	Ch 17	-	-		
	Ch 18	-	-		
	Ch 19	-	-		
	Ch 20	-	-		

Figure 14. Opening DC2212_THERMOCOUPLE_BOARD.cfg





Loading The Configuration from a Daughter Board

The demo software has a corresponding configuration for each daughter board. Figure 15 shows such a setup.

The DC2211 Universal Temperature Measurement board is shown at the top right of Figure 15. It includes a sense resistor and a diode. The measured sense resistance was stored on an EEPROM chip when the DC2211 was tested.



Figure 15. Setup with DC2211 Daughter Board



To load the configuration from the daughter board, do the following:

- 1) Plug the setup, which should look similar to what is shown in Figure 15, into a computer.
- 2) In the Configuration menu, select "Load from daughter board."

The software will search for the daughter board, find the appropriate configuration, and load the device values from the EEPROM. The results of loading the DC2211 daughter board are shown in Figure 16.

Click on the Ch 2 Edit button to see the loaded value for the sense resistor.

Refer to the DC2399 demonstration manual for details on interfacing the DC2211 to Thermistors, RTDs, and Thermocouples.

	Use	Sensor	Edit Out (uV, ohm)	Out (deg C)	Status byte
₽	Ch 1	- 🗸			
≥⊸⊡	Ch 2	Sense Resistor 🗸 🗸			
-	Ch 3	- 🗸			
₽	Ch 4	- 🗸			
₽	Ch 5	- 🗸			
√ K – ∎	Ch 6	Off-Chip Diode 🗸 🗸			
	Ch 7	- 🗸			

Figure 16. Main Screen After Loading from Daughter Board





RUNNING THE TESTBENCH

To run the program from the menu bar, go to Evaluate \rightarrow Run, or press the run button in the toolbar. An example output for a given configuration is shown in Figure 17.

The LTC2984 demo software continuously scans and measures the sensors from top to bottom. The sensor just measured is highlighted. To turn off a sensor, uncheck the corresponding "use" check box.

Seeing Output Errors

In order to demonstrate the fault reporting capabilities of the LTC2984, the DC2212 thermocouple board is used. Its

configuration automatically loaded using the "Load from Daughter Board" command in the configuration menu. The thermocouple on Channel 1 was removed from the board. The channel with an error is then shown in red, as shown in Figure 18. By hovering the mouse over the status byte, the user can see the corresponding errors, as shown in the figure.

To stop the run, either go to Evaluate \rightarrow Stop, or press the red "x" button on the toolbar. The program will scan down to the last sensor and then stop.

	Use	Sensor	Edi	t Out (uV, ohm)	Out (deg C)	Status byte
Cold jn:	Ch 1 🗹	Type J Thermocouple		-2.5224609375	23.55	00000001
‴~ √ ∛ ─ ■	Ch 2 🗹	Off-Chip Diode 🗸		0.630859375	23.81	00000001
Cold jn:	Ch 3 🔽	Type K Thermocouple		-8.3173828125	23.01	00000001
‴ ₅⊀ ■	Ch4 🗹	Off-Chip Diode 🗸		0.6298828125	24.01	00000001
-	Ch 5	- 🗸				
₅⊸	Ch 6	- 🗸				
⋛─₽	Ch 7	Sense Resistor 🗸				
<u></u> <u></u>	Ch 8	- •				
Ĩ [™]	Ch 9 🗹	RTD PT-100		109.19433593	23.25	00000001

Figure 17. Main Screen When Running the Program

	Use	Sensor	Edit	Out (uV, ohm) Out (Deg C)	Status by	te
Cold jn:	⊢Ch 1 🗹	Type J Thermocouple	•	2097151.0	-999.00	11001011	Sensor Hard Fault
<u>۲</u>	┣ Ch 2 🔽	Off-Chip Diode	•	0.631835937	25.60	0000001	Hard ADC Out-of-Range Sensor Overrange
Cold jn:	HCh 3 🗹	Type K Thermocouple	•	-35.0507812	23.66	00000001	ADC Out OF Range
Ç KI−−∎	┣Ch 4 🗹	Off-Chip Diode	-	0.6328125	25.48	0000001	
€ √_	🗜 Ch 5 🗹	Type J Thermocouple	•	0.721679687	0.02	0000001	=
اح	<mark>}−</mark> Ch 6	-	-				
	<mark>}−</mark> Ch 7	Sense Resistor	•				
	<mark>}−</mark> Ch 8	-	-				
	HCh 9 🗹	RTD PT-100	-	109.6855468	24.50	00000001	

Figure 18. Main Screen After the Thermocouple on Channel 1 Is Disconnected. While Not Shown in the Screenshot, the Mouse Is Hovering Over the Channel 1 Status Byte



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RUNNING THE TESTBENCH

Storing the Output

A file called "output.txt" should be in the main project directory. This file has all the results from the run, including the measured voltages or resistances, temperatures, and status codes. The file is tab-delimited, which means the data can be copied and pasted into Excel. A part of this output is shown in Figure 19.

× ×	licrosoft Ex	cel - output.	txt										
Aria	al	▼ 10 ▼	BIU	!│≣ ≣ :	a ∎ \$	% , *.0) .00 🗐 🕯	⊭ ∣⊞ - <u>⊀</u>	<u>></u> - <u>A</u> -				
:	🖻 🖬 💪	1 🖪 🖪 🗳	۵ 🔏 🖾 ۹	da 🛍 🔻 🎸	8 I II - (H	- 😫 Σ	$\overline{}$	🛄 🛷 100	0% 🖣 🕜	-			
:	🐮 Ele Edit View Insert Format Tools Data Window Help 🔹 🗗 🗙									₽×			
: 边	🛅 ங 🖄 🖾 🍋 🦷 🏷 🕃 🍢 🕼 🖓 Reply with Changes End Review 💂												
	B6	-	fx.										
	S	Т	U	V	W	Х	Y	Z	AA	AB	AC	AD	
1													
2	Ch 19 (uV)	Ch 20 (uV)	Ch 1 (C)	Ch 2 (C)	Ch 3 (C)	Ch 4 (C)	Ch 5 (C)	Ch 6 (C)	Ch 7 (C)	Ch 8 (C)	Ch 9 (C)	Ch 10 (C)	Ch
3			24.27	23.92	23.59	24.08					23.36		
4			24.24	23.98	23.54	24.09					23.37		
5			24.16	24.14	23.59	24.07					23.33		~
H 4													
Read	y										NUN	1	

Figure 19. One Part of the output.txt File (Copied Into Excel)





The LTC2984 can create C code for the configuration in the main screen. This code can be directly loaded into a Linduino (see www.linear.com/linduino) and executed.

To see an example, go to Configuration \rightarrow Open, navigate to example_config_files, and select DC2211_universal_tem-

perature_measurement_daughter_board.cfg. Then, from the menu bar, go to C Code \rightarrow Create C Code and select an appropriate folder. There should be a message similar to that shown in Figure 20:

ITC2984 Demo - DC2211_UNIVERS	AL_TEMPERATURE_	MEASUREMENT_BOARD.cfg			
Configuration Evaluate C	Code Setting	s Help			
) 🛃		1 7 0		TRENGU
			LTC2	2984 TES	STBENCH
		TECHNOLOGY	Edit Out (u) (ohm)	Out (Dog C)	Status buto
	Ch1	- •		Our (Deg C)	Status byte
5	Ch 2	Sense Resistor			
	Ch 3				
	Ch 4	-			
	Ch 5	- +			
<u>г-Ю-</u>		Off-Chip Diode 🗸		1	
v	□ - Ch 7	- +			_
	C code generated				
	Code is C:\User:	stored in s\tkaplan\Desktop\LTC2984			
			ОК		
	Ch 13				
	Ch 14	- •			
	Ch 15	- •			
	Ch 16				
	Ch 17				
	Ch 18	- •			
	Ch 19				
	Ch 20	- •			

Figure 20. Main Screen After the "Generate C Code" Toolbar Button Was Pressed



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Navigate to the folder selected, and go into the "LT2984" folder in order to see a file called LTC2984.ino, as well as

support functions and configuration constants. Screenshots of LTC2984.ino are shown in Figure 21a and Figure 21b.

💿 LTC2984 Arduino 1.6.4				x
File Edit Sketch Tools Help				
				ø
LTC2984 LTC2984_configuration_constants.h	LTC2984_support_functions.cpp	LTC2984_support_functions.h	LTC2984_table_coeffs.h	
#include <arduino.h></arduino.h>				-
<pre>#include <stdint.h> #include <stdint.h></stdint.h></stdint.h></pre>				
#include "SPL.b"				
#include "Wire.h"				
#include "Linduino.h"				
#include "LT_SPI.h"				
#include "UT I2C b"				
#include "QuikEval_EEPROM.h"				
#include "stdio.h"				
#include "math.h"				
#include "LTC2984 configuration constants h				
#include "LTC2984 support functions.h"				-
<pre>#include "LTC2984_table_coeffs.h"</pre>				=
<pre>// Function prototypes woid configure channels():</pre>				
<pre>void configure global parameters();</pre>				
// Configure the LTC2984				
initialize serial();				
initialize_spi();				
<pre>configure_channels(); configure_clobal_parameters();</pre>				
<pre>configure_grobal_balameters(); }</pre>				
•				•
1			Arduino Uno on COM	v119

Figure 21a. Top Part of Generated C Code





💿 LTC2984	Arduino 1.6.4				x
File Edit Ske	etch Tools Help				
					ø
LTC2984	LTC2984_configuration_constants.h	LTC2984_support_functions.cpp	LTC2984_support_functions.h	LTC2984_table_coeffs.h	
					*
vola confi by	<pre>gure_channels() { te channel_number;</pre>				
10	ng channel_assignment_data;				
11	Channel 2: Assign Sense Re	sistor			
ch	annel_assignment_data =				
	(long) SENSOR_TYPESENSE_R (long) 0b000000111110100000	ESISTOR 000000000 << SENSE RESISTOR VA	LUE LSB; // s	ense resistor - value: 2	2000.
as	sign_channel(2, channel_assignmen	t_data);	,≣3 32 (d) (d) (d)		
// ch	Channel 6: Assign Off-Chip annel assignment data =	Diode			
	(long) SENSOR_TYPE_OFF_CHI	P_DIODE			
	(long) DIODE_SINGLE_ENDED (long) DIODE_NUM_READINGS	2			
	(long) DIODE_AVERAGING_OFF	1			
	(long) DIODE_CURRENT_20UA_	80UA_160UA	ICD. // diada	Jacian Garage (state) - 1 (000000
as	sign_channel(6, channel_assignmen	t_data);	L3D; // aloae - 1	.deality factor(eta): i.t	102999
3					
void confi	gure_global_parameters() {				
vr	Set global parameters ite single byte(0xF0, TEMP UNIT	C I			
	REJECTION_50_60_HZ);		-		
// WE	Set any extra delay between c ite single byte(0xFF, 0);	onversions (in this case, 0*10	lOus)		
}					
//	Run the LTC2984				
void loop() {				
fl	oat temperature_result;				
	ee enamer_namer,				
in	<pre>t channels_to_measure[] = {6}; t num measured channels = sizeof(</pre>	channels to measure)/sizeof/ch	annels to measure[0]).		
			amero_co_measare[0]//		
fo	r (int i = 0: i < num measured ch	annels: i++) (=
	channel_number = channels_t	o_measure[i];			
	convert_channel(channel_num)	ber);			
	read_voltage_or_resistance_	results(int(channel_number));			
	read_temperature_results(in	<pre>nt(channel_number));</pre>			
}					
,					
3					•
1				Arduino Uno on	COM19

Figure 21b. Bottom Part of Generated C Code



Even without a Linduino, one can get a good idea how to program the LTC2984 by examining the generated C code.

C-code for all demonstration boards and each example shown in the data sheet are included in the Linduino sketchbook.

However, the file should be ready to load and run on a Linduino. For further information on how to set up a Lin-

duino, go to www.linear.com/linduino. Once user generated C-code is uploaded into the Linduino, the demonstration software will no longer run. In order to run the demonstration software, the default DC590 code needs to be reloaded into the Linduino board. This is accomplished by opening the Arduino IDE, selecting from the sketchbook Utilities \rightarrow DC590B, and uploading to the Linduino (see Figure 23).



Figure 22. Warning to Load Original Linduino Code Back in

👓 sketch_jun02a Ar	duino 1.0.5		
File Edit Sketch Tools	Help		
New	Ctrl+N		
Open	Ctrl+O		~
Sketchbook	Þ	Part Number 🔹 🕨	
Examples	•	User Contributed 🕨	
Close	Ctrl+W	Utilities 🕨 🕨	DC590B
Save	Ctrl+S		I2C_Address_Scan
Save As	Ctrl+Shift+S		LTC24XX_general_test
Upload	Ctrl+U		MyBlink
Upload Using Programmer	Ctrl+Shift+U		Serial_EEPROM_Test
Page Setup	Ctrl+Shift+P		
Print	Ctrl+P		
Preferences	Ctrl+Comma		
Quit	Ctrl+Q		
			<u>v</u>
			Arduino Uno on COM40



2984dsmf



CUSTOM SENSORS

Loading In Custom Coefficients and Tables

The LTC2984 demo software allows custom coefficients for thermocouples, RTDs and thermistors. The basic method is shown below: Create a new configuration on the menu by choosing Configuration \rightarrow New. Select a custom thermocouple on Channel 3, and click the Edit button on Channel 3. The form in Figure 24 will open.

The thermocouple form now has three new entries: The custom address, the custom length (number of coefficients -1) and the custom values. The custom address is where the user wishes to store the thermocouple table, the length is the length of the data, and the values open a text editor to input the custom values (Figure 25).

The data has comma-separated x, y values. The x unit is mV (for thermocouples) and Ohms (for RTDs and thermistors). The y unit is always kelvin. The x values must be monotonically increasing.

The first table entry for thermocouples is the mV value corresponding to 0 kelvin. The first table entry for RTDs and thermistors is the temperature corresponding to 0Ω output. This first table entry is used for extrapolation when readings are below the normal range of the sensor. The remaining entries are the valid sensor specific data.

In this example a custom thermocouple is used. The first entry –10mV, 0 kelvin is the point used for extrapolation of data below the first valid data point (100mV, 199 kelvin).

Custom values	
-45,0 0,273.15 10,380 20,510	
< ×	
OK Cancel	1

Figure 25. Custom Value Editor

🚺 Ch 7 Custom Thermocouple	Configuration	on	
	Value	Change to	Accept
tc - cold junction ch	-	-	Changes
tc - differential?	No	No 💌	Cancel
tc - open ckt detect?	No	No	
tc - open ckt detect current	10uA	10uA 💌	
tc - custom address	0	0	
tc - custom length-1	0	0	
tc - custom values	(0 values)		
Channel assignment	0100100000	100000000000000000000000000000000000000	

Figure 24. Configuring a Custom Thermocouple. The Window Is Similar When a Custom RTD or Thermistor Is Selected



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CUSTOM SENSORS

The valid data consists of three table entries. Combined with the extrapolation point, four pairs of data are entered into the device. The value for tc – custom length–1 should be 3 in this example (length-1). If the user inputs an incorrect number this results in an error (see Figure 26). Once the correct length is entered and Accept Changes is clicked, the LTC2984 is programmed with the custom table data.

A Thermistor Custom Steinhart-Hart table file should look like Figure 27. There are always six Steinhart-Hart coefficients to enter, from A through F.

As was the case before, the LTC2984 can create C code for this configuration, including the custom coefficients. This code can be directly loaded into a Linduino and run.

Ch 7 Custom Thermocouple Con	figuration Value	Change to	Accept
tc - cold junction ch tc - differential? tc - open ckt detect? tc - open ckt detect current tc - custom address tc - custom length-1 tc - custom values	- No No 10uA 0 0 (0 values)	- • • • • • • • • • • • • • • • • • • •	Cancel
Channel assignment	010010000010	000000000000000000000000000000000000000	
Error tc - custom length-1: tc - custor	n length-1 set to	4, but since the table length is 4, tc - c	sustom length-1 should be 3

Figure 26. Error Message When Choosing the Wrong Custom Length



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USING THE EEPROM

The LTC2984 allows the user to easily load and save configuration data into its EEPROM. To show this feature in action, do the following:

 Choose a demo board from the configuration: for example, "Configuration" → "Load example" → "Demo board" → "DC2212_THERMOCOUPLE_BOARD.cfg." The screen will look like that in Figure 28.

	Use	Sensor	Edit Out (uV, ohm)	Out (Deg C)	Status byte
Cold jn:	Ch1 🔽	Type J Thermocouple 🗸			
~~ ₽	Ch 2 🔽	Off-Chip Diode 🗸			
Cold jn:	Ch 3 🔽	Type K Thermocouple 🔹		1	
Ç-{{}-∎-	Ch 4 🔽	Off-Chip Diode 🗸			
	- Ch 5 🔽	Type J Thermocouple 🗸			
ا ر	Ch 6				
2-⊡-	Ch 7	Sense Resistor 👻			
<u></u>	Ch 8				
² \$⊡	Ch 9 🔽	RTD PT-100 -			
₹√	Ch 10 🔽	Type J Thermocouple 🗸			

Figure 28. Thermocouple Board Configuration





USING THE EEPROM

- 2) Attach the setup as shown in Figure 15 into a computer. For this exercise, a daughter board is not needed.
- Load the configuration into EEPROM: Go to "Configuration" → "EEPROM" → "Load into EEPROM." The message in Figure 29 appears if everything worked correctly.



Figure 29. Message Showing Successful Load into EEPROM

 Go to "Configuration" → "New." The configuration should now be empty. 5) Let the LTC2984 go through a power cycle by unplugging and replugging in the USB connection to the DC2026 Linduino demo board.

Load the EEPROM back into the LTC2984 by going to "Configuration" \rightarrow "EEPROM" \rightarrow "Retrieve from EEPROM." After a successful operation, the original configuration in Figure 28 will reappear, and the software shows the message in Figure 29.

EEPROM	A communications success	3		
Data was successfully retrieved from EEPROM				
	ОК			

Figure 30. Message Showing Successful Retrieval from EEPROM





2984dsm

LTC2984DSM

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