LT3669-2
IO-Link Device with Multiple Sensors

DESCRIPTION

Demonstration circuit 2227A is a complete IO-Link® device built using the LT®3669-2 to implement an IO-Link v1.1 physical interface (PHY). The IO-Link stack protocol runs on an Atmel ATmega microcontroller which connects to LT3669-2's logic IO-signals to communicate with an IO-Link master via the CQ1 transceiver.

An LTC2997 temperature sensor, an opto-coupler (light barrier) and a pushbutton demonstrate IO-Link device functionality and master-slave interoperability.

A 28V/100mA light bulb connected to LT3669-2's second driver (Q2) demonstrates its high current driving capabilities. All low voltage circuitry is supplied by the LT3669-2's integrated buck and LDO for high efficiency.

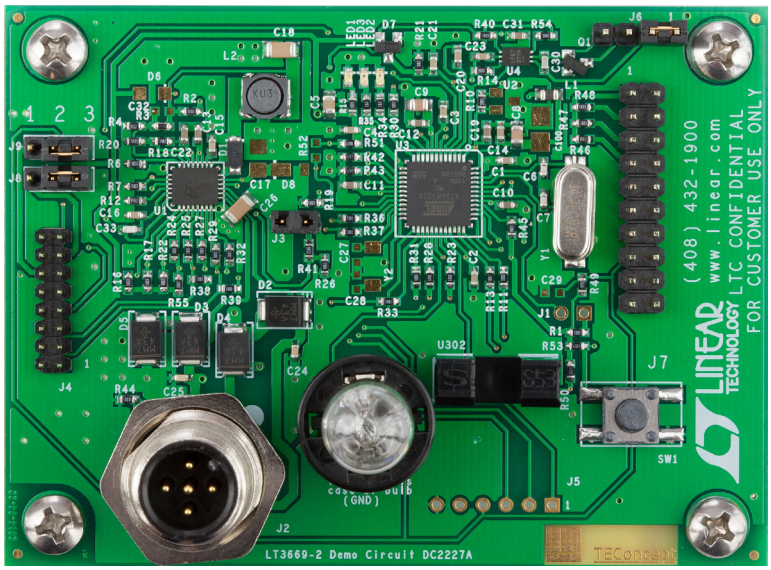
Design files for this circuit board are available at http://www.linear.com/demo/DC2227A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, V_L+ = 24V

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
L+	Input Supply		18		36	V
V_{BUCK}	LT3669-2's Buck Output Voltage		3.8	4	4.2	V
V_{LDO}	LT3669-2's LDO Output Voltage		3.135	3.3	3.465	V

BOARD PHOTO



QUICK START PROCEDURE

Additional Hardware and Software Requirements

To operate the DC2227A demo circuit in IO-Link mode, additional hardware and software are required:

- PC running Windows XP or later with Ethernet Card. Alternatively a USB-to-Ethernet adaptor can also be used
- LTC IO-Link Master Demo Circuit DC2228A
- DC2228A Control Tool Software
- PoE Injector or 24V Power Supply
- DC2227A IODD Files (COM2 and COM3)

Set-up Preparation (See Figures 1 and 2)

1. Download and install the DC2228A Control Tool software from:

   www.linear.com/demo/DC2228A

2. Connect the DC2228A to power and the host computer. Refer to the DC2228A demo manual for detailed information about the different configuration options to supply the DC2228A and interface it to the PC.
3. Using a 3-wire IO-Link cable of up to 20m in length with M12 connectors, plug the male terminal to one of the 8-ports of the DC2228A (for example port 2 like in Figure 1) and the female terminal to the DC2227A.
4. Run the DC2228A Control Tool on the PC and connect to the DC2228A. See the DC2228A demo manual for detailed information of how to select the DC2228A as the master, configure the IP parameters and establish communication between the host computer and the master.

Operation in IO-Link Mode (See Figures 1 and 2)

5. Download the DC2227A IODD files from:

   www.linear.com/demo/DC2227A

6. Click on the “Select Device” button and import the IODD files by selecting the downloaded xml files and then clicking on the “Import” button (one at a time).

Operation in COM2

7. Click on the “Select Device” button again, this time making sure the correct port is selected. Use the following IODD file:

   TEConcept_GmbH-65538-<YYYYMMDD>-IODD1.1.xml

8. If the device is off, switch it on, enabling the L+ supply of the connected master’s port by pressing the “Power ON” button keeping the light barrier open during power-up. If the device was already powered on coming from COM3 mode, power cycle it keeping the light barrier open to restart the device in COM2 mode. See the Light Barrier section for more information.
9. Start IO-Link communication by pressing the “IO-Link” button. The “Min. Cycle Time” is set to 20ms.
10. If a different IODD file is to be selected, stop IO-Link communication first by pressing the “Inactive” button to revert the DC2227A into SIO mode.

Operation in COM3

11. Click on the “Select Device” button again making sure the correct port is selected. Use the following IODD file:

    TEConcept_GmbH-65539-<YYYYMMDD>-IODD1.1.xml

12. If the device is off, switch it on, enabling the L+ supply of the connected master’s port by pressing the “Power ON” button keeping the light barrier closed during power-up. If the device was already powered on coming from COM2 mode, power cycle it keeping the light barrier closed to restart the device in COM3 mode. See the Light Barrier section for more information.
13. Start IO-Link communication by pressing the “IO-Link” button. The “Min. Cycle time” is set to 800µs.
14. If a different IODD file is to be selected, stop IO-Link communication first by pressing the “Inactive” button to revert the DC2227A in SIO mode.

QUICK START PROCEDURE

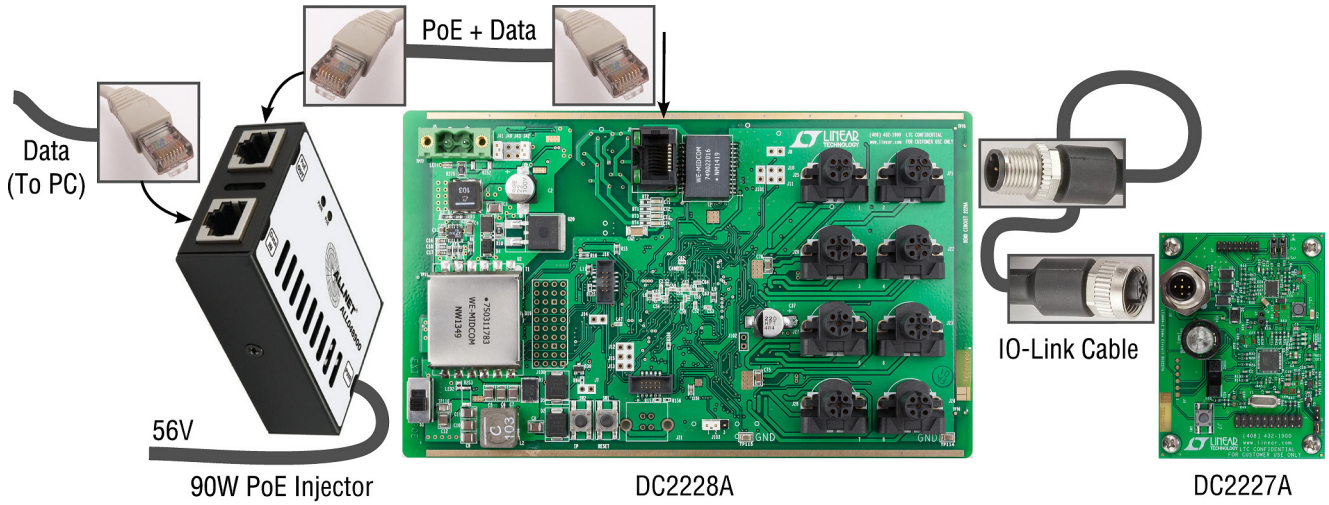


Figure 1. Recommended Set-up for Operating DC2227A in IO-Link Mode

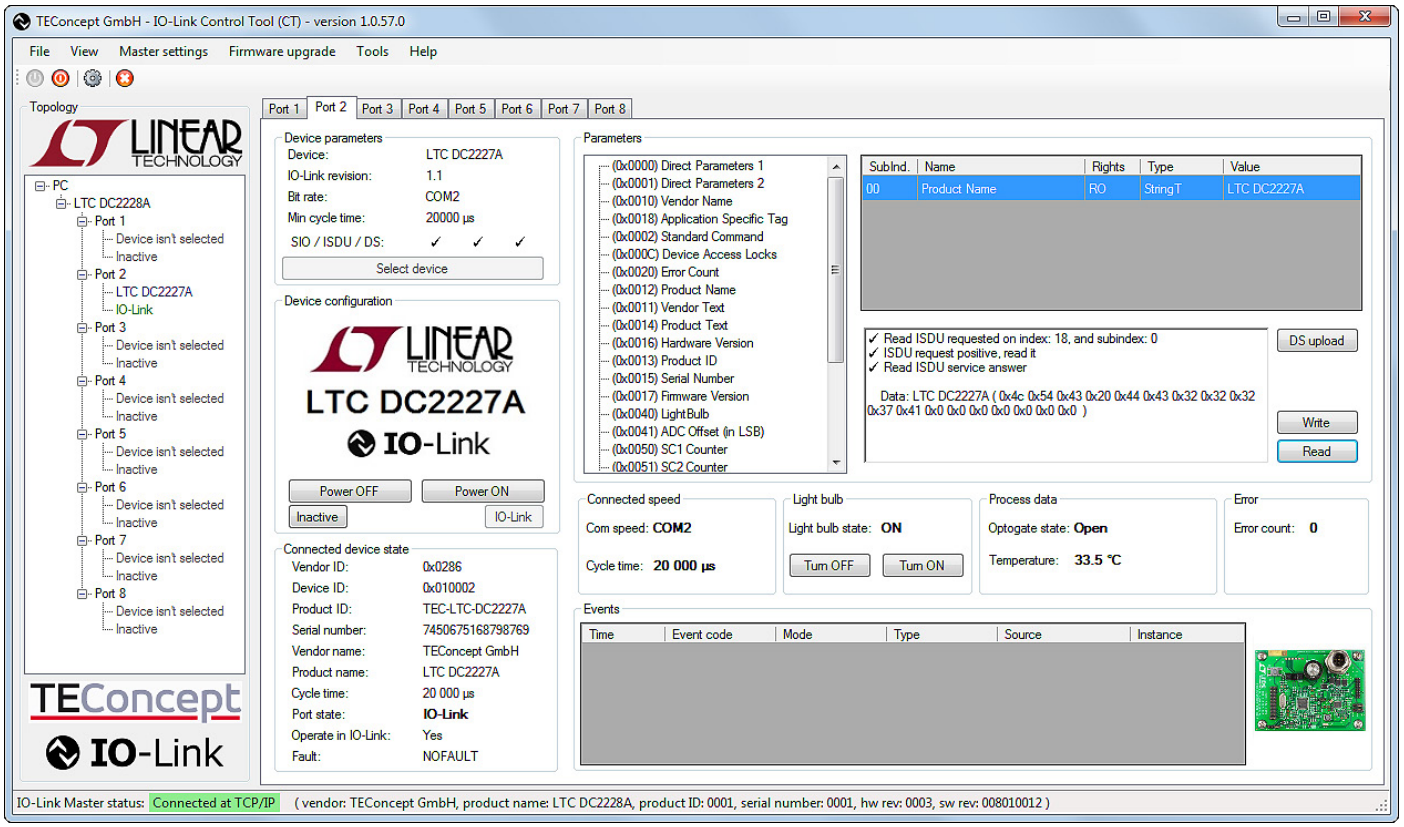


Figure 2. Control Tool for Connecting DC2227A to DC2228A

ADDITIONAL INFORMATION

Operation in SIO Mode

The device can also operate in SIO mode. In this mode, no IO-Link communication takes place either because the master connected to the device is in the "Inactive" mode and it only supplies power to the device, or because there is no master connected to the device in which case the device is powered by a 24V supply. In SIO mode, the DC2227A reacts to the status of the light barrier as follows:

- If the light barrier is open, then drivers CQ1 and Q2 actively pull low. Since the onboard light bulb is connected between Q2 and ground, it is therefore turned off.
- If the light barrier is closed (by placing a piece of paper in its gap), CQ1 and Q2 actively pull high and the light bulb attached to Q2 turns on.

Temperature Sensor Configurations

In IO-Link mode, the DC2227A reports cyclically to the master (and thus to the PC Control Tool) the temperature measured by the on-board LTC2997. In order to measure temperature the LTC2997 uses an NPN configured as a diode. The NPN can be either on-chip, on PCB (Q1) or remote. Refer to the Connectors and Jumpers section for detailed information on how to choose the NPN.

Microcontroller ADC's Offset Correction

The 12-bit ADC of the Atmel microcontroller samples both, the precise 1.8V reference voltage (V_{REF}) and the VPTAT outputs of the LTC2997 to report the temperature in Celsius to the IO-Link master. The temperature is then calculated using a ratiometric measurement. The µC's ADC is specified to have offsets from –40 to 40 LSBs. The temperature equation is:

$$100 \bullet T(^{\circ}C) = \frac{ADC7 - OFFSET}{ADC4 - OFFSET} \bullet 45000 - 27315$$

ADC7 is the ADC's code for the VPTAT output and ADC4 the code for the precise 1.8V V_{REF}. OFFSET is the ADC's offset (in LSB) parameter that can be set using the control tool (default is 0 LSB). In order to improve the accuracy of the temperature reading, a calibrated thermometer can be used to measure the temperature close to the LTC2997 and then the ADC Offset parameter can be set to the value (after several tries) that minimizes the error between the temperature reported by the Control Tool and that given by the calibrated thermometer.

Event Generator

The DC2227A is also equipped with a pushbutton to simulate events generated by IO-Link devices to inform IO-Link masters of requests that require special attention.

Light barrier

The light barrier offers many ways to interact with the device. It starts the device in COM3 mode if it is closed during power-up or in COM2 mode if left open. In IO-Link mode, its status is reported live on the PC control tool and in SIO mode its status is directly coupled to the CQ1 and Q2 drivers, thus allowing the user to operate the light bulb.

Light bulb

A 28V/100mA light bulb connects between Q2 and ground and serves to show the high current driving capability of the line drivers. It takes about 240ms to be turned on fully by the pulsing mechanism of the LT3669-2. To prevent data loss in IO-Link mode, driver Q2 is only enabled in between IO-Link telegrams. To turn it on and off from the control tool (in COM2 only) simply press the "Turn On" and "Turn Off" buttons within the light bulb section. In SIO mode, regardless on the IODD file chosen, the light bulb can be switched on and off by interacting with the light barrier.

ADDITIONAL INFORMATION

Connectors and Jumpers

The board has the following connectors:

Table 1. Connectors and Jumpers Overview

Name	Type	Form	Comment
J1	Jumper	Pin-2	Atmel µC Flash Erase
J2	Connector	M12	IO-Link Signals (L+, L–, CQ1, Q2)
J3	Jumper	Pin-2	LT3669-2 EN/UVLO Pin
J4		Header 8 × 2_2mm	Eval Board DC1733
J5	Connector	Pin-6	SPI Interface
J6	Jumper	Pin-4	Sensor Selection
J7	JTAG	Header10 × 2	JTAG Programming
J8	Jumper	Pin-3	VDD3 Select
J9	Jumper	Pin-3	Reset Select

Jumper J1

Jumper J1 sets the Erase/PB12 pin of the microcontroller to VDD3 (3.3V). By default the J1 header is not populated. For details about the Erase/PB12 pin see the ATSAM31S2AA microcontroller data sheet.

Connector J2

Connector J2 is a 5-pin M12 male connector. Plug a standard industrial sensor cable to this connector to supply and communicate to the DC2227A using an IO-Link master. Table 2 shows the internal pin assignments to the LT3669-2 IO-Link PHY:

Table 2. Connector J2 Pinout

M12 Pin	LT3669-2's Pin	Comment
1	L+	DC2227A Input Supply (24V)
2	Q2	LT3669-2 Second Driver
3	GND	DC2227A Ground Node
4	CQ1	LT3669-2 Transceiver (IO-Link)
5	Not Connected	

Jumper J3

Jumper J3 enables/disables the on board LT3669-2 (which also generates the internal 3.3V supply rail). Close this jumper (default position) to use the onboard LT3669-2 as the IO-Link PHY (it will start up for L+ voltages above 14.8V). Leave this jumper open if the external DC1733A-B board is used (via the J4 connector) as the IO-Link PHY instead.

Connector J4

J4 is for connecting an external DC1733A-B demo circuit bypassing the on-board LT3669-2. This connection allows access to more signals from LT3669-2. Connect jumper J3 from DC1733A-B pin-to-pin to jumper J4 on this board. Table 3 identifies each pin.

Table 3. Connector J4 Pinout

Pin	Function	Comment
1	TXD2	DC1733A-B Driver Input (Q2)
2	TXEN2	DC1733A-B Driver Input (Q2)
3	TXD1	DC1733A-B Driver Input (CQ1)
4	TXEN1	DC1733A-B Driver Input (CQ1)
5	RXD1	DC1733A-B Receiver Output (CQ1)
6	GND	DC1733A-B Ground
7	WAKEn	DC1733A-B Wake-Up Output
8	GND	DC1733A-B Ground
9	SC2n	DC1733A-B Driver Short Circuit Output (Q2)
10	SC1n	DC1733A-B Driver Short Circuit Output (CQ1)
11	GND	DC1733A-B Ground
12	RST_n	DC1733A-B POR Reset Output
13	$V_{DD(EXT)}$	DC1733A-B LDO's Output (3.3V)
14	GND	DC1733A-B Ground
15	TP33	DC1733A-B Buck Output (5V)
16	SYNC	DC1733A-B Buck Oscillator Synchronization Input

ADDITIONAL INFORMATION

Connector J5

J5 is currently unused and may be helpful for the customer's own applications that make use of the SPI interface of the Atmel microcontroller.

Table 4. Connector J5 SPI Pinout

Pin	Function	Comment
1	MISO	Master In Slave Out
2	MOSI	Master Out Slave In
3	SPCK	SPI Clock
4	RESETn	Reset
5	VDD3	Power
6	GND	Ground

Jumper J6

J6 configures the sense device used by the LTC2997 to measure temperature. It could be either the LTC2997's internal diode, the on-board diode-connected NPN Q1 or a remote NPN (connected as a diode) using a twisted pair:

Table 5. Jumper J6 Pinout (Temperature Sense Device)

Pin	Description	Comment
1	LTC2997's V_{CC}	Close 1-2 to Use the LTC2997's Int. NPN
2	LTC2997's D+	To Base/Collector of Remote NPN
3	Q1's Base/Collector	Close 2-3 to Use the On-board NPN Q1
4	LTC2997's D–	To Emitter of Remote NPN

Connector J7

Standard 20-pin JTAG programming/debugging interface. This interface fits many JTAG/ICE connectors.

Table 6. JTAG Connector Pinout

Pin	Function	Comment
1, 2	VDD3	
3	VDD3	Via 100k
5	TDI	
7	TMS	
9, 11	TCK	
13	TDO	
15	RESETn	
17, 19	N.C.	
6, 8, 10, 12, 14, 16, 18, 20	GND	

Jumper J8

J8 selects the source for the VDD3 power.

Table 7. VDD3 Source Select Pinout

Pin	Description	Comment
1	DC1733A-B's LDO	Close 1-2 to Use DC1733A-B as PHY
2	Local VDD3 rail	Default: Connected to Pin 3
3	Local LT3669-2's LDO	Close 2-3 to Use Local LT3669-2 as PHY

Jumper J9

J9 selects the source for the microcontroller's reset pin.

Table 8. Reset Source Select Pinout

Pin	Description	Comment
1	DC1733A-B RSTn	Close 1-2 to use DC1733A-B as PHY
2	Local RESETn	Default: Connected to Pin 3
3	Local LT3669-2 RSTn	Close 2-3 to Use Local LT3669-2 as PHY

Indicators

The following indicators are available:

Table 9. Indicators

Name	Comment
LED1	ON (Green) if Device Is Powered up
LED2	ON (Red) if µC Started Successfully
LED3	ON (Red) if Device Is in IO-Link Mode
LP1	28V/100mA Light Bulb Between Q2 and GND

TVS Protection

The CQ1, Q2 and L+ pins are protected by 39V TVS diodes. Do not connect to any voltage higher than 36V.

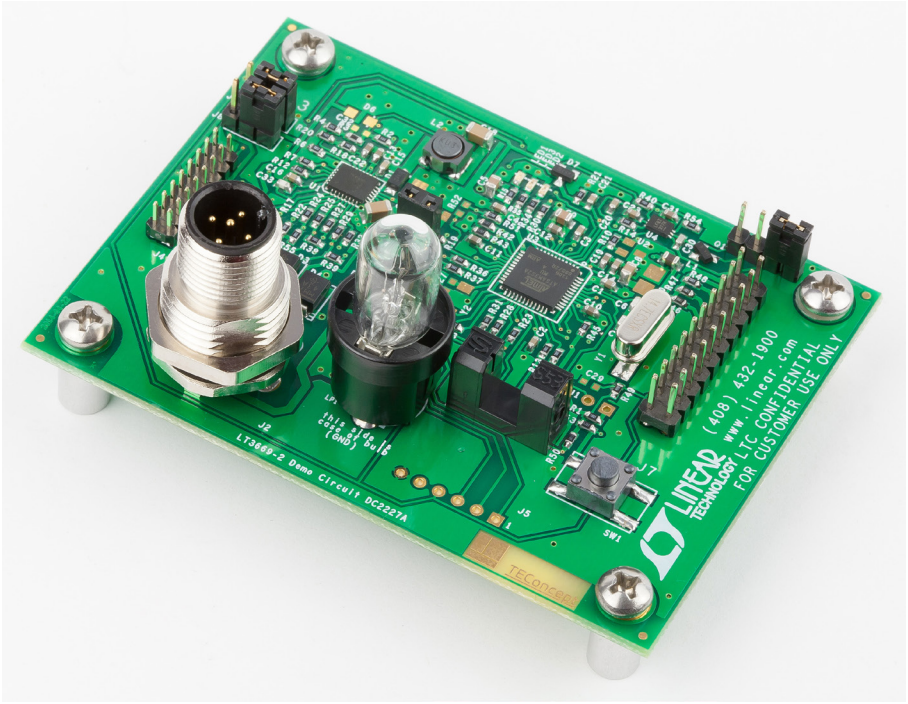
Data Storage

Data Storage is not currently supported by DC2227A. Do not use pushbutton "DS upload" in Control Tool Software.

IO-Link Firmware

The firmware contained in the Atmel microcontroller is intellectual property owned by TEConcept GmbH in Germany. Any attempt to copy, transfer, or reverse engineer the firmware is forbidden. The source code or an object library for the IO-Link stack can be licensed from TEConcept.

ADDITIONAL INFORMATION



IO Device Description

IODD File (COM2): TEConcept_GmbH-65538-<YYYYMMDD>-IODD1.1 Release Date: <YYYY-MM-DD> Document Version: V1.0 Device ID: 65538 Bit Rate: COM2 IO-Link Version: 1.1 MinCycleTime: 20ms	**IODD File (COM3):** TEConcept_GmbH-65539-<YYYYMMDD>-IODD1.1 Release Date: <YYYY-MM-DD> Document Version: V1.0 Device ID: 65539 Bit Rate: COM3 IO-Link Version: 1.1 MinCycleTime: 800µs
Device Basic Data: SIO Mode Supported: Yes Device: LTC DC2227A Vendor ID: 646 Vendor Name: TEConcept GmbH Vendor Text: www.teconcept.de/www.linear.com Description: TEConcept-LTC IO-Link DemoDeviceBoard V1.2	

Process Data

Name	Description	Datatype	Bit Offset	Bit Length	Value Range	Gradient	Offset	Unit
Optogatestate	State of Light Barrier	Boolean	15	1	0 to 1			
Temperature	Temperature Measured Using the LTC2997	IntegerT	0	15	–32768 to 32767	0.1	0	°C

Events

Code	Name	Type	Mode	Description
30480	Demo/Test Error	Error	Event Single Shot	This Event Is Issued When the Demo Board Button Has Been Pressed. Also Used During the Conformance Tests

ADDITIONAL INFORMATION

Variables

Name	Description	Index	Subindex	Datatype	Length	Access Rights	Default	Value Range	Unit
System Command	Command Code Definition	2	00	UIntegerT	8 Bit	wo			
Device Access Locks	Standardized Device Locking Functions	12	00	RecordT	1 Bit	rw		-	
Parameter (Write) Access Lock	Parameter Write Access	12	01	BooleanT	1 Bit	rw	0	0 or 1	
Data Storage Lock	Data Storage	12	02	BooleanT	1 Bit	rw	0	0 or 1	
Local Parameterization Lock	Local parameterization	12	03	BooleanT	1 Bit	rw	0	0 or 1	
Local User Interface Lock	Local User Interface Operation	12	04	BooleanT	1 Bit	rw	0	0 or 1	
Vendor Name	Informative	16	00	StringT	Max. 64 Byte	ro	TEConcept GmbH		
Vendor Text	Additional Vendor Information	17	00	StringT	Max. 64 Byte	ro	www.teconcept.de www.linear.com	-	
Product Name	Detailed Product or Type Name	18	00	StringT	Max. 64 Byte	ro	LTC DC2227A	-	
Product ID	Product or type identification	19	00	StringT	Max. 64 Byte	ro	TEC-LTC DC2227A	-	
Product Text	Description of Device function or Characteristic	20	00	StringT	Max. 64 Byte	ro	TEC-LTC IO-Link DC2227A	-	
Serial Number	Vendor Specific SN	21	00	StringT	Max. 16 Byte	ro	-		
Hardware Version	Vendor Specific Format	22	00	StringT	Max. 64 Byte	ro	2.0	-	
Firmware Version	Vendor Specific Format	23	00	StringT	Max. 64 Byte	ro	1.2.5	-	
Application Specific Tag	Tag location or Tag Function Defined by User	24	00	StringT	Max. 32 Byte	rw	Testing********…		
Error Count	Errors Since Power-On or Reset	32	00	UIntegerT	16 Bit	ro		-	
Light Bulb	Light Bulb State	64	00	BooleanT	1 Bit	rw	0	0 or 1	
ADC Offset (in LSB)	ADC Offset (in LSB)	65	00	IntegerT	8 Bit	rw	0	–128 to 127	LSB
SC1 Counter	Short Circuit Counter on CQ1	80	00	UIntegerT	16 Bit	ro	0	0 to 65535	
SC2 Counter	Short Circuit Counter on Q2	81	00	UIntegerT	16 Bit	ro	0	0 to 65535	
Overtemp Counter	Counts Overtemperature Events	82	00	UIntegerT	8 Bit	ro	0	0 to 255	
4mvK	ADC Input Parameter for Temperature Measurement (LTC2997's VPTAT)	90	00	UIntegerT	12 Bit	rw	0	0 to 4095	LSB
1V8	ADC Input Parameter for Temperature Measurement (LTC2997's V_{REF})	91	00	UIntegerT	12 Bit	rw	0	0 to 4095	LSB

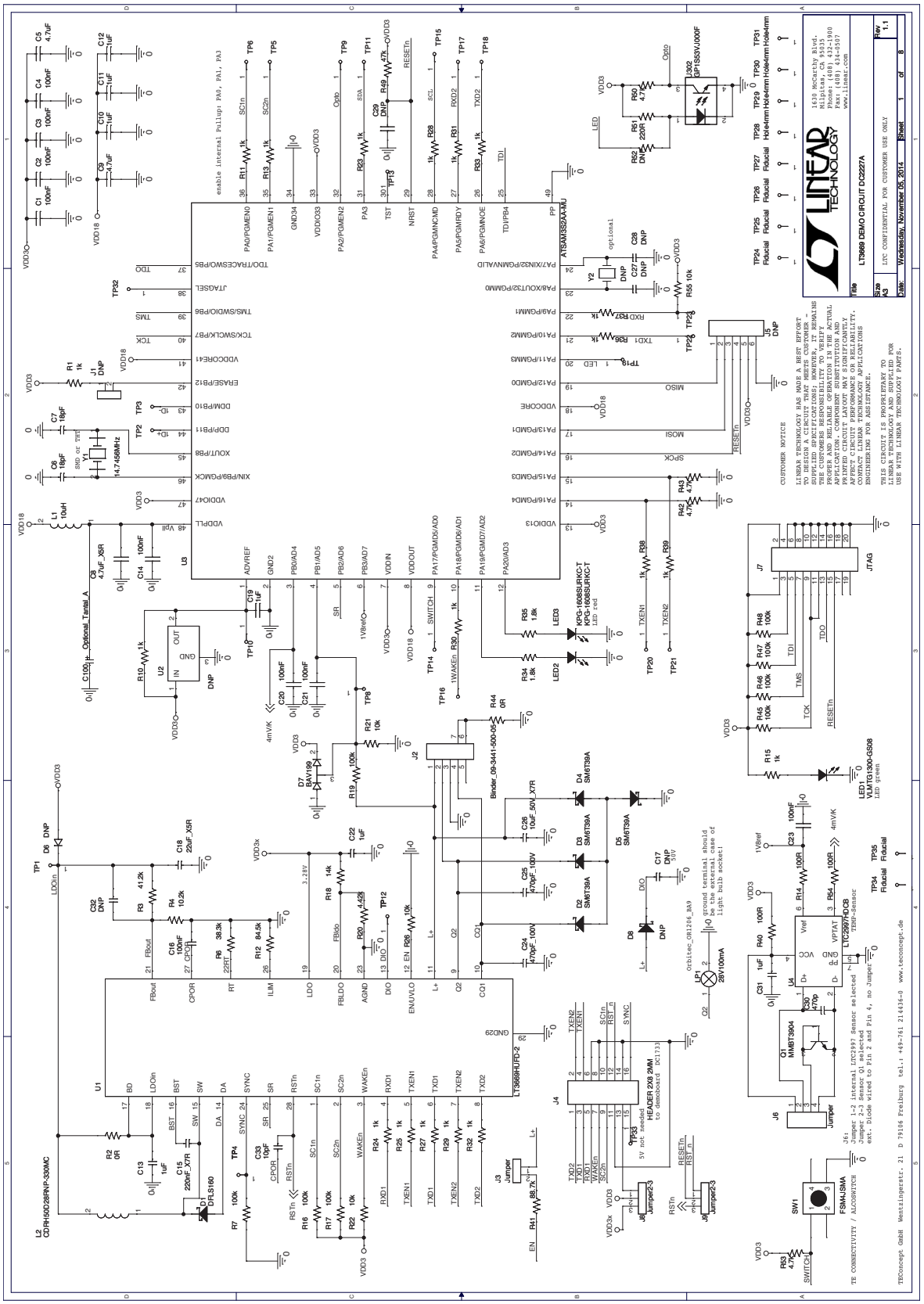
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	6	C1, C2, C3, C4, C14, C16	CAP, X5R, 100nF, 10%, 10V, 0603	AVX, 0603ZD104KAT2A
2	3	C5, C8, C9	CAP, X5R, 4.7µF, 10%, 10V, 0805	MURATA, GRM21BR71A475KA73L
3	2	C6, C7	CAP, NP0, 18pF, 10%, 25V, 0603	AVX, 06033A180KAT2A
4	5	C10, C11, C12, C13, C22	CAP, X5R, 1µF, 10%, 10V, 0603	MURATA, GRM188R61A105KA61D
5	1	C15	CAP, X7R, 220nF, 10%, 10V, 0603	AVX, 0603ZC223KAT2A
6	1	C18	CAP, X5R, 22µF, 10%, 10V, 1206	MURATA, GRM31CR61A226KE19L
7	2	C24, C25	CAP, NP0, 470pF, 10%, 100V, 0603	TDK, C1608C0G2A471K080AA
8	1	C26	CAP, X7R, 10µF, 10%, 50V, 1206	MURATA, GRM31CR61H106KA12L
9	1	C33	CAP, X7R, 10pF, 10%, 10V, 0603	AVX, 0603ZC100KAT2A
10	1	D1	DIODE, SCHOTTKY, POWERDI123	DIODES INC., DFLS160-7-F
11	4	D2, D3, D4, D5	DIODE, TVS, SMB_2C	VISHAY, SM6T39A
12	1	L1	IND, 10µH, 0.2A, 0805	TAIYO YUDEN, CB2012T100MRV
13	1	L2	IND, 33µH, 1A, SMD 6 × 6	SUMIDA, CDRH50D28RNP-330MC
14	1	R3	RES, 41.2k, 1%, 1/10W, 0603	VISHAY, CRCW060341K2FKEA
15	1	R4	RES, 10.2k, 1%, 1/10W, 0603	VISHAY, CRCW060310K2FKEA
16	1	R6	RES, 38.3k, 1%, 1/10W, 0603	VISHAY, CRCW060338K3FKEA
17	2	R16, R17	RES, 100k, 1%, 1/10W, 0603	VISHAY, CRCW0603100KFKEA
18	1	R12	RES, 84.5k, 1%, 1/10W, 0603	VISHAY, CRCW060384K5FKEA
19	1	R18	RES, 14k, 1%, 1/10W, 0603	VISHAY, CRCW060314K0FKEA
20	1	R20	RES, 4.42k, 1%, 1/10W, 0603	VISHAY, CRCW06034K42FKEA
21	2	R22, R55	RES, 10k, 1%, 1/10W, 0603	VISHAY, CRCW060310K0FKEA
22	2	R42, R43	RES, 4.7k, 1%, 1/10W, 0603	VISHAY, CRCW06034K70FKEA
23	1	R49	RES, 47k, 1%, 1/10W, 0603	VISHAY, CRCW060347K0FKEA
24	1	U1	IC, INDUSTRIAL TRANSCEIVER	LINEAR TECH, LT3669HUFD-2#PBF
25	1	U3	IC, MICROCONTROLLER, QFN48	ATMEL, ATSAM3S2AA-MU
26	1	Y1	CRYSTAL, 14.7456 MHz, HC-49 SMD	RALTRON, AS-14.7456-18SMDT
Temperature Sensor Specific Components				
1	2	C20, C23	CAP, X5R, 100nF, 10%, 10V, 0603	AVX, 0603ZD104KAT2A
2	2	C19, C31	CAP, X5R, 1µF, 10%, 10V, 0603	MURATA, GRM188R61A105KA61D
3	1	C30	CAP, X7R, 470pF, 10%, 10V, 0603	AVX, 0603ZC471KAT2A
4	1	Q1	XSTR, NPN, 40V, SOT23	Fairchild, MMBT3904
5	1	R10	RES, 1k, 1%, 1/10W, 0603	VISHAY, CRCW06031K00FKEA
6	3	R14, R40, R54	RES, 100Ω, 1%, 1/10W, 0603	VISHAY, CRCW0603100RFKEA
7	1	U4	IC, TEMPERATURE SENSOR	LINEAR TECH., LTC2997HDCB#PBF
Light Barrier Specific Components				
1	4	R50	RES, 4.7k, 1%, 1/10W, 0603	VISHAY, CRCW06034K70FKEA
2	1	R51	RES, 220Ω, 1%, 1/10W, 0603	VISHAY, CRCW0603220RFKEA
3	1	U302	XSTR, LIGHT SENSING	SHARP, GP1S53VJ000F

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Push-Buttom Specific Components				
1	1	R53	RES, 4.7k, 1%, 1/10W, 0603	VISHAY, CRCW06034K70FKEA
2	1	SW1	SWITCH, PUSHBUTTON	WÜRTH ELEKTRONIK, 430182050816
Additional Demo Board Circuit Components:				
1	1	C21	CAP, X5R, 100nF, 10%, 10V, 0603	AVX, 0603ZD104KAT2A
2	0	C17	OPTIONAL	
3	0	C27, C28, C29, C32	OPTIONAL	
4	0	C100	OPTIONAL	
5	0	D6	OPTIONAL	
6	1	D7	DIODE, SOT23	DIODES INC., BAV199-7-F
7	0	D8	OPTIONAL	
8	1	LED1	LED, 0603D	VISHAY, VLMTG1300-GS08
9	2	LED2, LED3	LED, 0603D	KINGBRIGHT, KPG-1608SURKC-T
10	18	R1, R11, R13, R15, R23, R24, R25, R27, R28, R29, R30, R31, R32, R33, R36, R37, R38, R39	RES, 1k, 1%, 1/10W, 0603	VISHAY, CRCW06031K00FKEA
11	2	R2, R44	RES, 0Ω, 1%, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
12	8	R7, R19, R45, R46, R47, R48	RES, 100k, 1%, 1/10W, 0603	VISHAY, CRCW0603100KFKEA
13	2	R21, R26	RES, 10k 1%, 1/10W, 0603	VISHAY, CRCW060310K0FKEA
14	2	R34, R35	RES, 1.8k, 1%, 1/10W, 0603	VISHAY, CRCW06031K80FKEA
15	1	R41	RES, 88.7k, 1%, 1/10W, 0603	VISHAY, CRCW060388K7FKEA
16	0	R52	OPTIONAL	
17	0	U2	OPTIONAL	
18	0	Y2	OPTIONAL	
Hardware-For Demo Board Only:				
1	0	J1	OPTIONAL	
2	1	J3	HEADER, 1 × 2, 0.1"	WÜRTH ELEKTRONIK, 61300211121
3	1	J2	CONNECTOR, M12, 5 PIN	BINDER, 09-3441-500-05
4	1	J4	HEADER 2 × 8 2mm	WÜRTH ELEKTRONIK, 62001621121
5	0	J5	OPTIONAL	
6	1	J6	HEADER, 1 × 4, 0.1"	WÜRTH ELEKTRONIK, 61300411121
7	1	J7	HEADER, 2 × 10, 0.1 "	WÜRTH ELEKTRONIK, 61302021121
8	2	J8, J9	HEADER, 1x3, 0.1"	WÜRTH ELEKTRONIK, 61300311121
9	5	J3, J6-J9	SHUNT, 0.1"	WÜRTH ELEKTRONIK, 60900213421
10	1	LP1	SOCKET, LAMP SOCKET, WEDGE, T3 1/4	CML INNOVATIVE TECH., LH10
11	1		BULB, WEDGE, 28V, .1A, 1.6M	JKL Components, 400
12	1		CABLE, 2M 4-WIRE UNSHIELDED	BINDER, 79-5001-20-04
13	4		STANDOFF, 6-32 ALUM 3/8"	DIGI-KEY, 3486K-ND
14	4		MACHINE SCREW, PAN PHILLIPS 6-32, 3/8"	KEYSTONE, 9904
15	4		LOCK WASHER, #6	KEYSTONE, 4700
16	4		FLAT WASHER, #6, NYLON	KEYSTONE, 3122

SCHEMATIC DIAGRAM



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