

LTC4227-1/LTC4227-2/ LTC4227-3/LTC4227-4 Dual Ideal Diode and Single Hot Swap Controller

DESCRIPTION

Demonstration circuit 1625A is intended to demonstrate performance of the [LTC4227-1/LTC4227-2/LTC4227-3/LTC4227-4](#) dual ideal diode and Hot Swap™ controller. Each rail has an individual ideal diode. Ideal diode outputs are connected to the load through a single Hot Swap circuit.

The DC1625 allows verifying the LTC4227 Hot Swap and ideal diode functionality during individual supply ramp-up and ramp-down transients, during power supply switch-over, steady state, and overcurrent fault conditions.

Each DC1625A rail circuit is assembled to operate over the full operating voltage range of the LTC4227: 2.9V to 18V, with a 7.6A maximum current load.

The board's main components include the LTC4227 controller, two power MOSFETs controlled as ideal diodes and one power MOSFET controlled as a Hot Swap device, two

jumpers for enabling the second ideal diode (D2ON_SEL) and Hot Swap controller (HS_ON), two LEDs to indicate power good (PWRGD) and fault (FAULT) conditions, seven banana jacks for connecting power supplies and load, many turrets and pads for observing circuit signals.

Table 1. DC1625A Assembly Options

| VERSION | PART | OVERCURRENT FAULT | START-UP DELAY |
|-----------|-----------|-------------------|----------------|
| DC1625A-A | LTC4227-1 | LATCHOFF | 100ms |
| DC1625A-B | LTC4227-2 | RETRY | 100ms |
| DC1625A-C | LTC4227-3 | LATCHOFF | 1.6ms |
| DC1625A-D | LTC4227-4 | RETRY | 1.6ms |

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

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PERFORMANCE SUMMARY (T_A = 25°C)

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|----------------------------|---|---|------------|------------|--------------|----------|
| Supplies | | | | | | |
| V _{IN} | Input Supply Range | | 2.9 | | 18.0 | V |
| V _{INTVCC} | Internal Regulator Voltage | | 4.5 | 5 | 5.6 | V |
| V _{INTVCC(UVL)} | Internal V _{CC} Undervoltage Lockout | INTV _{CC} Rasing | 2.1 | 2.2 | 2.3 | V |
| Ideal Diode Control | | | | | | |
| ΔV _{FWD(REG)} | Forward Regulation Voltage (V _{INn} - V _{SENSE}) | | 10 | 25 | 40 | mV |
| ΔV _{DGATE} | External N-Channel Gate Drive (V _{DGATEn} - V _{INn}) | IN < 7V, ΔV _{FWD} = 0.1V IN = 7V to 18V, ΔV _{FWD} = 0.1V | 5 10 | 7 12 | 14 14 | V V |
| I _{CPO(UP)} | CPOn Pull-Up Current | CPO = IN = 2.9V CPO = IN = 18V | -60 -50 | -95 -85 | -120 -110 | μA μA |
| I _{DGATE(FPU)} | DGATEn Fast Pull-Up Current | ΔV _{FWD} = 0.2V, ΔV _{DGATE} = 0V, CPO = 17V | | -1.5 | | A |
| I _{DGATE(FPD)} | DGATEn Fast Pull-Down Current | ΔV _{FWD} = -0.2V, ΔV _{DGATE} = 5V | | 1.5 | | A |
| I _{DGATE2(DN)} | DGATE2 Off Pull-Down Current | D2ON = 2V, ΔV _{DGATE2} = 2.5V | 40 | 100 | 200 | μA |
| t _{ON(DGATE)} | DGATEn Turn-On Delay | ΔV _{FWD} = 0.2V, C _{GATE} = 10nF | | 0.25 | 0.5 | μs |
| t _{OFF(DGATE)} | DGATEn Turn-Off Delay | ΔV _{FWD} = -0.2V, C _{GATE} = 10nF | | 0.2 | 0.5 | μs |
| t _{PLH(DGATE2)} | D2ON Low to DGATE2 High | | | 40 | 100 | μs |

dc1625afa

DEMO MANUAL DC1625A

PERFORMANCE SUMMARY (T_A = 25°C)

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------|--|---|---------------|--------------|---------------|---------|
| Hot Swap Control | | | | | | |
| $\Delta V_{SENSE(CB)}$ | Circuit Breaker Trip Sense Voltage ($V_{SENSE^+} - V_{SENSE^-}$) | | 47.5 | 50 | 52.5 | mV |
| $\Delta V_{SENSE(ACL)}$ | Active Current Limit Sense Voltage ($V_{SENSE^+} - V_{SENSE^-}$) | | 60 | 65 | 70 | mV |
| ΔV_{HGATE} | External N-Channel Gate Drive ($V_{HGATE} - V_{OUT}$) | IN < 7V, I = 0, -1 μ A IN = 7V to 18V, I = 0, -1 μ A | 4.8 10 | 7 12 | 14 14 | V V |
| $I_{GATE(UP)}$ | External N-Channel Gate Pull-Up Current | Gate Drive On, HGATE = 0V | -7 | -10 | -13 | μ A |
| $I_{HGATE(DN)}$ | External N-Channel Gate Pull-Down Current | Gate Drive Off, OUT = 12V, HGATE = OUT + 5V | 150 | 300 | 500 | μ A |
| $I_{HGATE(FPD)}$ | External N-Channel Gate Fast Pull-Down Current | Fast Turn-Off, OUT = 12V, HGATE = OUT + 5V | 100 | 200 | 300 | mA |
| Input/Output Pin | | | | | | |
| $V_{SENSE^+(UVL)}$ | SENSE+ Undervoltage Lockout | SENSE+ Rising | 1.75 | 1.9 | 2.05 | V |
| $V_{ON(TH)}$ | ON Pin Threshold Voltage | ON Rising | 1.21 | 1.235 | 1.26 | V |
| $V_{ON(RESET)}$ | ON Pin Fault Reset Threshold Voltage | ON Falling | 0.55 | 0.6 | 0.65 | V |
| $V_{D2ON(TH)}$ | D2ON Pin Threshold Voltage | D2ON Rising | 1.21 | 1.235 | 1.26 | V |
| $V_{TMR(TH)}$ | TMR Pin Threshold Voltage | TMR Rising TMR Falling | 1.198 0.15 | 1.235 0.2 | 1.272 0.25 | V V |
| $I_{TMR(UP)}$ | TMR Pull-Up Current | TMR = 1V, In Fault Mode | -75 | -100 | -125 | μ A |
| $I_{TMR(DN)}$ | TMR Pull-Down Current | TMR = 2V, No Faults | 1.4 | 2 | 2.6 | μ A |
| $I_{TMR(RATIO)}$ | TMR Current Ratio $I_{TMR(DN)}/I_{TMR(UP)}$ | | 1.4 | 2 | 2.7 | % |

OPERATING PRINCIPLES

The LTC4227 is intended to build a combination of two diode-OR circuits (for two rails) and a common single Hot Swap path for inrush current limiting and overcurrent protection.

The LTC4227 regulates the forward voltage drop across the MOSFETs to ensure smooth current transfer from one supply to other without oscillation. A fast turn-on reduces the load voltage droop during supply switchover. If the input supply fails or is shorted, a fast turn-off minimizes reverse current transients.

The Hot Swap fast acting current limit and internal timed circuit breaker protect circuit components when a short-circuit fault occurs.

The Hot Swap function on the LTC4227 controller has independent on/off control.

Each ideal diode MOSFET is activated from individual charge pump sources and the second ideal diode path has additional on/off control.

The LTC4227-1 and LTC4227-3 feature a latching circuit breaker, while the LTC4227-2 and the LTC4227-4 provide automatic retry after a fault.

QUICK START PROCEDURE

Demonstration circuit 1625A is easy to set up to evaluate the performance of the LTC4227. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

The DC1625A test includes independent test of the LTC4227 hot swapping functionality and ideal diode functionality.

HOT SWAP FUNCTIONALITY TEST

This test is performed with single rail operation, when the rail output is provided through two series connected MOSFETs. One MOSFET functions as an ideal diode and other one as a Hot Swap circuit component.

The parameters of the three transients in different operation modes completely characterize the Hot Swap circuit performance. These actions are:

- A power-up without any additional load
- A current limit operation after successful power-up transient
- A power-up with shorted output

1. Initially, install the jumper heads in the following positions, if the first ideal diode is used in the test:

JP1 EN_SEL in the position LOW

JP2 D2ON_SEL in the position OFF

JP3 ON_SEL in the position OFF

If the second ideal diode is used:

JP1 EN_SEL in the position LOW

JP2 D2ON_SEL in the position ON

JP3 ON_SEL in the position OFF

Connect a 12V power supply to the board input turrets IN1 (or IN2) and GND. Do not load the output. Place the current probe on the 12V wire and voltage probes on the OUT turret.

Provide ON signal at the ON pin by changing the JP3 jumper header position from OFF position to ON. Observe the transient. The output voltage rise time should be in the range of 12ms to 29ms. PWRGD green LED D3 (D5) must turn on. Turn off the rail using the ON jumper.

2. Connect a disabled electronic load to the OUT turret and GND. Turn on the rail and slowly increase the load current up to the circuit breaker threshold level. The current limit range should be from 7.8A to 8.9A.

The DC1625A-A and DC1625-C circuit feature a latching circuit breaker, and DC1625A-B and the DC1625-D provide automatic retry after a fault.

Turn off the rail with the ON_SEL jumper.

3. Initially short output with external wire. Place the current probe at this external wire. Turn on the rail and record the current shape. The maximum current should be in the 10.1A to 11.8A range.

QUICK START PROCEDURE

IDEAL DIODE FUNCTIONALITY TEST

In this test, both ideal diodes are active and small variations in the input voltage forces one ideal diode to be off and another ideal diode to be on.

Connect input turrets (IN1 and IN2) of each ideal diode with individual independent lab supply. Adjust each input voltage to 12V with maximum possible accuracy. Place

one voltmeter between IN1 and IN2 turrets to measure the difference between two input voltages. Connect an electronic load to the output turret. Activate both rail and keep a load around 1A to 3A. Play with input voltage levels and be sure that when the difference between input voltages exceeds 40mV, only one rail feeds the load.

QUICK START PROCEDURE

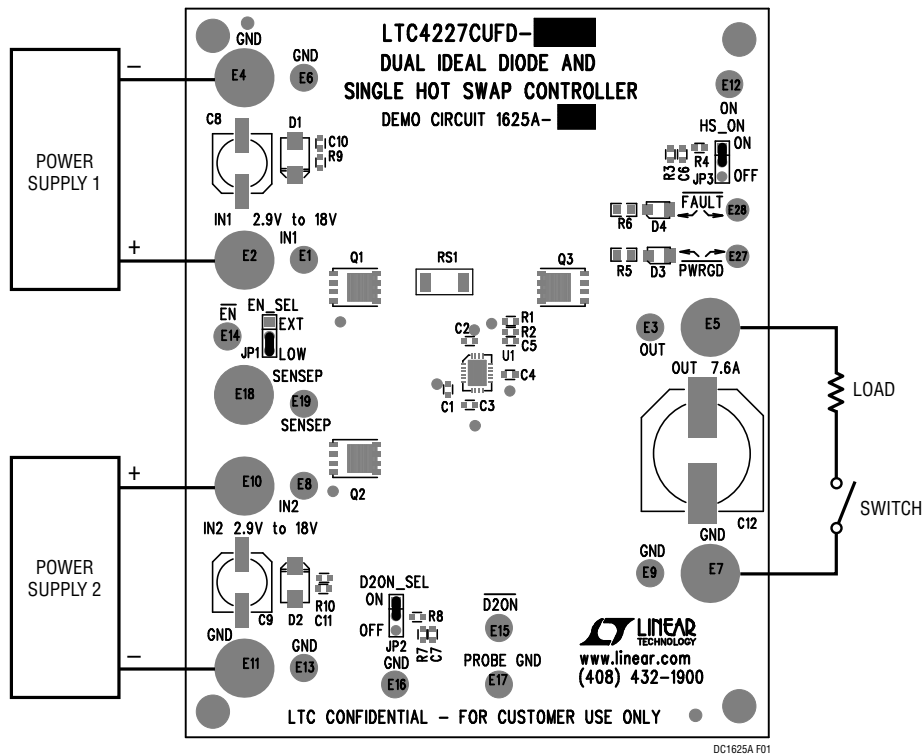


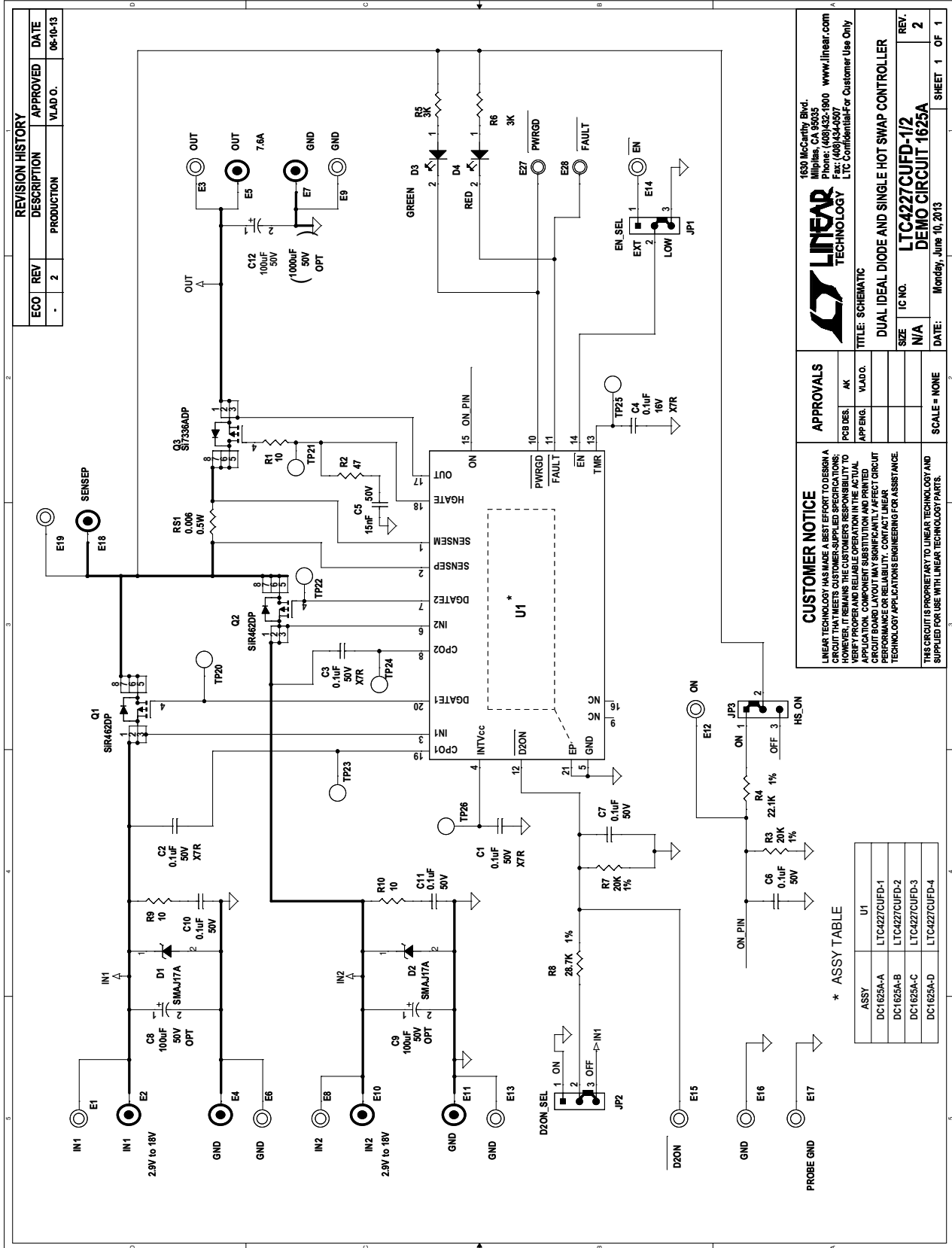
Figure 1. DC1625A Measurement Equipment Setup

DEMO MANUAL DC1625A

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|----------------------------|-----|----------------------------------|----------------------------------|-----------------------------------|
| DC1625A General BOM | | | | |
| 1 | 8 | C1, C2, C3, C4, C6, C7, C10, C11 | CAP, X7R, 0.1µF, 50V, 0603 | TDK, C1608X7R1H104K |
| 2 | 1 | C5 | CAP, X7R, 15nF, 50V, 0603 | AVX, 06035C153KAT |
| 3 | 0 | C8, C9 OPT | CAP, AL, EI, S/M 100µF, 50V | SUNCON, 50CE100BS |
| 4 | 1 | C12 | CAP, AL, EI, S/M 100µF, 50V | SUNCON, 50CE100BS |
| 5 | 0 | C12 OPT | CAP, AL, EI, S/M 1000µF, 50V | NIC, NACEW102M50V16X17TR13F |
| 6 | 2 | D1, D2 | DIODE, VOLTAGE SUPPRESSOR, SMA | DIODES, SMAJ17A-13-F |
| 7 | 1 | D3 | LED, SMT GREEN | PANASONIC, LN1351CTR |
| 8 | 1 | D4 | LED, SMT RED | PANASONIC, LN1261CTR |
| 9 | 11 | E1, E3, E6, E8, E9, E12 to E17 | TURRET, TESTPOINT, 2501 | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 10 | 7 | E2, E4, E5, E7, E10, E11, E18 | JACK BANANA | KEYSTONE, 575-4 |
| 11 | 2 | E27, E28 | TURRET, TESTPOINT, 2308 | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 12 | 3 | JP1, JP2, JP3 | HEADERS, 3 PINS 2mm CTRS | SAMTEC TMM-103-02-L-S |
| 13 | 3 | XJP1, XJP2, XJP3 | SHUNT, 2mm CTRS | SAMTEC 2SN-BK-G |
| 14 | 2 | Q1, Q2 | MOSFET, N-CHANNEL, 30V | VISHAY, SiR462DP-T1-GE3 |
| 15 | 1 | Q3 | MOSFET, N-CHANNEL, 30V | VISHAY, Si7336ADP-T1-GE3 |
| 16 | 1 | RS1 | RES, CHIP, 0.006, 1/2W, 1%, 2010 | KOA, TLR2HDBK6L00F75 |
| 17 | 3 | R1, R9, R10 | RES, CHIP, 10, 1%, 0603 | VISHAY, CRCW060310R0FKEA |
| 18 | 1 | R2 | RES, CHIP, 47, 1%, 0603 | VISHAY, CRCW060347R0FKEA |
| 19 | 2 | R3, R7 | RES, CHIP, 20k, 1%, 0603 | VISHAY, CRCW060320K0FKEA |
| 20 | 1 | R4 | RES, CHIP, 22.1k, 1%, 0603 | VISHAY, CRCW060322K1FKEA |
| 21 | 2 | R5, R6 | RES, CHIP, 3k, 1%, 0805 | VISHAY, CRCW08053K00FKEA |
| 22 | 1 | R8 | RES, CHIP, 28.7k, 1%, 0603 | VISHAY, CRCW060328K7FKEA |
| 23 | 4 | STAND-OFF | STAND-OFF, NYLON 0.5" | KEYSTONE, 8833 (SNAP ON) |
| 24 | 1 | | STENCIL | STENCIL 1625A |
| DC1625A-A | | | | |
| 1 | 1 | DC1625A | General BOM | |
| 2 | 1 | U1 | I.C. LTC4227CUFD-1, QFN20-4x5 | LINEAR TECHNOLOGY, LTC4227CUFD-1 |
| DC1625A-B | | | | |
| 1 | 1 | DC1625A | General BOM | |
| 2 | 1 | U1 | I.C. LTC4227CUFD-2, QFN20-4x5 | LINEAR TECHNOLOGY, LTC4227CUFD-2 |
| DC1625A-C | | | | |
| 1 | 1 | DC1625A | General BOM | |
| 2 | 1 | U1 | I.C. LTC4227CUFD-3, QFN20-4x5 | LINEAR TECHNOLOGY, LTC4227CUFD-3 |
| DC1625A-D | | | | |
| 1 | 1 | DC1625A | General BOM | |
| 2 | 1 | U1 | I.C. LTC4227CUFD-4, QFN20-4x5 | LINEAR TECHNOLOGY, LTC4227CUFD-4 |

SCHEMATIC DIAGRAM



| REVISION HISTORY | | | |
|------------------|-----|--------------------------------------|------------------|
| ECO | REV | DESCRIPTION | APPROVED DATE |
| - | 2 | PRODUCTION <td>VLAD O. 06-10-13</td> | VLAD O. 06-10-13 |

1625 McCarty Blvd.
 Milpitas, CA 95035
 Phone: (408)432-1900 www.linear.com
 Fax: (408)434-0307
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LINEAR TECHNOLOGY

TITLE: SCHEMATIC

DUAL IDEAL DIODE AND SINGLE HOT SWAP CONTROLLER

| | | |
|-------|-----------------------|--------------|
| SIZE | IC NO. | REV. |
| N/A | LTC4227CUFD-1/2 | 2 |
| DATE: | Monday, June 10, 2013 | SHEET 1 OF 1 |

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* ASSY TABLE

| ASSY | U1 |
|-----------|---------------|
| DC1625A-A | LTC4227CUFD-1 |
| DC1625A-B | LTC4227CUFD-2 |
| DC1625A-C | LTC4227CUFD-3 |
| DC1625A-D | LTC4227CUFD-4 |



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DEMO MANUAL DC1625A

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Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А