

## DEMO BOARD MANUAL DC324

### LTC1876 High Efficiency, Low Cost, 3-Output Power Supply

#### DESCRIPTION

Demonstration Board DC324 is a high efficiency, low cost design using the LTC<sup>®</sup>1876. This demo board provides three regulated outputs from a single IC: 3.3V/5A, 5V/5A and 12V/200mA, along with two LDO outputs at 3.3V and 5V. Using only a small number of surface mount components, this design is ideal for network equipment, notebook computers and other portable applications that require low profile, small board area and minimum system cost. High efficiency and low EMI are also achieved by operating the two main power stages 180° out of phase, which, in turn, results in long battery life and smaller input capacitors. All three main outputs can be adjusted externally and the 12V regulator is configured to receive its input from the 3.3V output, the 5V output or an external supply.

DC324 highlights the capabilities of the LTC1876, which incorporates a dual out-of-phase, step-down switching controller and a step-up regulator with an internal 1A, 36V switch. It uses a constant frequency, current mode architecture to provide excellent line and load regulation for all three outputs. The operating frequency of the step-down controller is DC programmable from 150kHz to 300kHz and the frequency of the step-up regulator is fixed at 1.2MHz, allowing the use of tiny, low cost capacitors and inductors. Protection features of the controller include an overvoltage soft latch, an overcurrent latch-off (which can be externally defeated) and internal current foldback for overload situations. At low output currents, two modes of operation are available: Burst Mode<sup>™</sup> operation to maintain high efficiency and burst disable mode to maintain constant frequency operation. The controller is also capable of very low dropout operation, with a 99% maximum duty cycle. To be compatible with battery operation, the input range of this demo board is 7.5V to 24V for the 3.3V and 5V outputs and from 3V to 10V for the 12V output. **Gerber files for this circuit board are available. Call the LTC factory.**

#### PERFORMANCE SUMMARY (Operating Temperature Range: 0°C to 50°C)

| PARAMETERS      | CONDITIONS                                                                                                   |                  | VALUE              |
|-----------------|--------------------------------------------------------------------------------------------------------------|------------------|--------------------|
| Input Voltages  | Step-Down Channels ( $V_{OUT} = 5V$ and $3.3V$ ); Limited by External MOSFET Drive and Breakdown Requirement |                  | 5.2V to 30V        |
|                 | Step-Up Channel ( $V_{OUT} = 12V$ )                                                                          |                  | 2.6V to 11V        |
| Output Voltages | Step-Down Channel 1; Externally Adjustable                                                                   |                  | $5.00V \pm 0.10V$  |
|                 | Step-Down Channel 2; Externally Adjustable                                                                   |                  | $3.30V \pm 0.07V$  |
|                 | Step-Up Channel; Externally Adjustable                                                                       |                  | $12.00V \pm 0.24V$ |
|                 | 5V Linear Regulator                                                                                          |                  | $5.00V \pm 4\%$    |
|                 | 3.3V Linear Regulator                                                                                        |                  | $3.30V \pm 4\%$    |
| Load Currents   | Step-Down Channels                                                                                           |                  | 0 to 5A, 6A Peak   |
|                 | Step-Up Channel                                                                                              | $V_{IN2} = 3.3V$ | 200mA              |
|                 |                                                                                                              | $V_{IN2} = 10V$  | 600mA              |

| PARAMETERS             | CONDITIONS                                                                                                                                                                           | VALUE               |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Frequencies            | Step-Down Channels; Externally Adjustable; FREQSET Pin Tied to INTV <sub>CC</sub>                                                                                                    | 300kHz              |
|                        | Step-Up Channel; Fixed                                                                                                                                                               | 1.2MHz              |
| Output Ripple Voltages | Step-Down Channel 1; 20MHz BW; V <sub>IN</sub> = 15V; I <sub>O</sub> = 5A                                                                                                            | 60mV <sub>P-P</sub> |
|                        | Step-Down Channel 2; 20MHz BW; V <sub>IN</sub> = 15V; I <sub>O</sub> = 5A                                                                                                            | 60mV <sub>P-P</sub> |
|                        | Step-Up Channel; 20MHz BW; V <sub>IN2</sub> = 5V; I <sub>O</sub> = 200mA                                                                                                             | 50mV <sub>P-P</sub> |
| Line Regulation        | Step-Down Channel 1; V <sub>IN</sub> = 7.5V to 24V                                                                                                                                   | ±5mV                |
|                        | Step-Down Channel 2; V <sub>IN</sub> = 7.5V to 24V                                                                                                                                   | ±5mV                |
|                        | Step-Up Channel; V <sub>IN</sub> = 3.3V to 10V                                                                                                                                       | ±5mV                |
| Load Regulation        | Step-Down Channel 1; V <sub>IN</sub> = 15V; V <sub>OUT1</sub> = 5.00V; I <sub>O</sub> = 0 to 5A                                                                                      | –60mV               |
|                        | Step-Down Channel 2; V <sub>IN</sub> = 15V; V <sub>OUT2</sub> = 3.30V; I <sub>O</sub> = 0 to 5A                                                                                      | –60mV               |
|                        | Step-Up Channel; V <sub>IN</sub> = 5V; V <sub>OUT3</sub> = 12.00V; I <sub>O</sub> = 0 to 200mA                                                                                       | –10mV               |
| Supply Current         | V <sub>IN</sub> = 15V; All Three Channels On; EXT <sub>CC</sub> = V <sub>OUT1</sub>                                                                                                  | 80μA*               |
| Shutdown Current       | V <sub>IN</sub> = 15V; STBYMD = 0                                                                                                                                                    | 20μA                |
| Standby Current        | V <sub>IN</sub> = 15V; 1MΩ Resistor from STBYBD to V <sub>IN</sub> ; 5V INTV <sub>CC</sub> and 3.3V LDO On; RUN/SS1 = RUN/SS2 = AUXSD = 0                                            | 170μA               |
| Efficiency             | V <sub>IN</sub> = 15V; V <sub>IN2</sub> = V <sub>OUT1</sub> ; 4A Load at 5V Channel (Not Including the Supply Current to 12V Channel); 5A Load at 3.3V Channel; 200mA at 12V Channel | 90%                 |

\*400μA including the supply current from EXT<sub>CC</sub>. Dynamic supply current is higher due to the gate charge being delivered at the switching frequency. See the LTC1876 data sheet for more information.

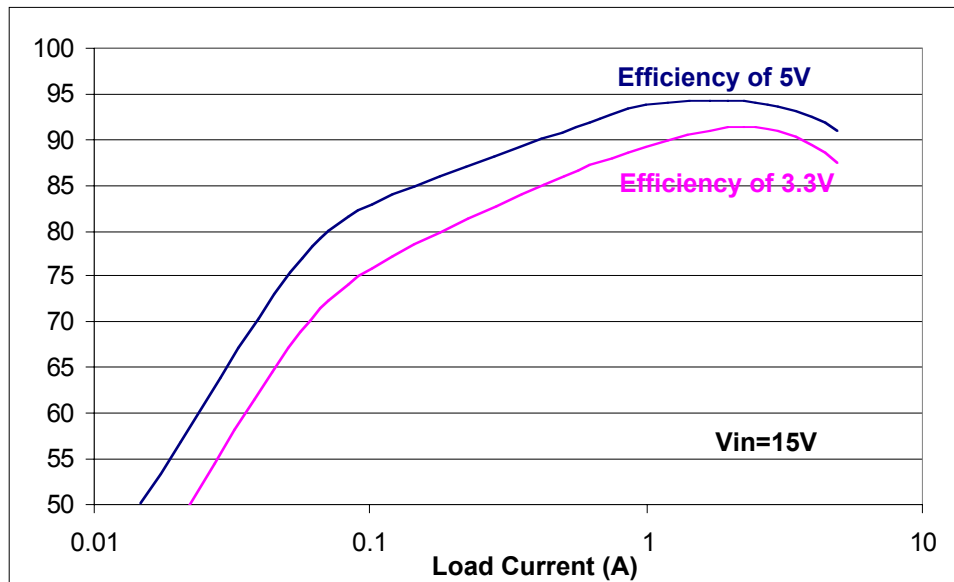
## TYPICAL PERFORMANCE CHARACTERISTICS

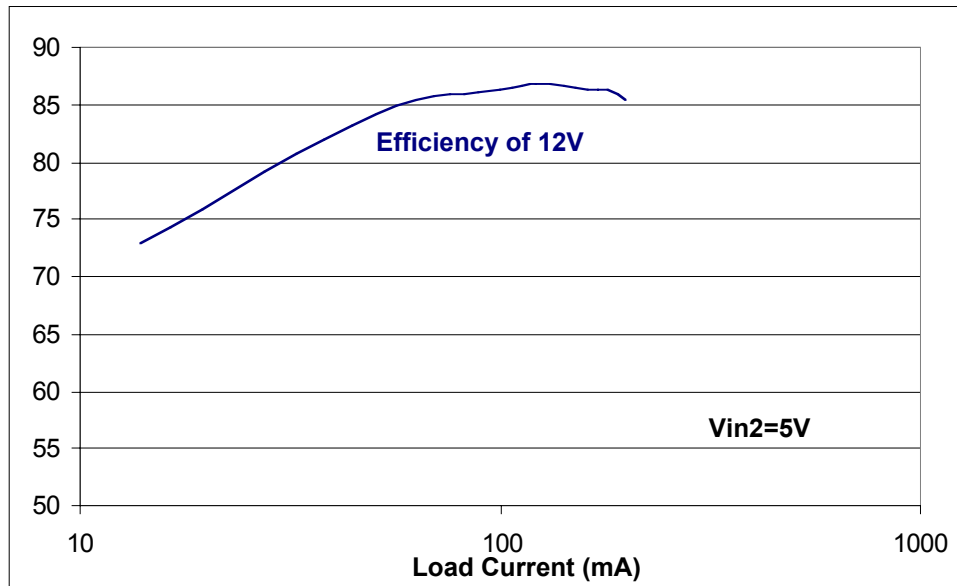
### 1; 5V Channel (Both 3.3V and 12V Channels are OFF)

| Vin(V) | Iin(A) | Vout(V) | Iout(A) | Eff.(%)  |
|--------|--------|---------|---------|----------|
| 15     | 0.004  | 5.02    | 0       | 0        |
| 15     | 0.01   | 5.01    | 0.015   | 50.1     |
| 15     | 0.023  | 5       | 0.052   | 75.36232 |
| 15     | 0.041  | 4.99    | 0.102   | 82.76098 |
| 15     | 0.182  | 4.99    | 0.496   | 90.66081 |
| 15     | 0.356  | 4.98    | 1.004   | 93.63146 |
| 15     | 0.706  | 4.98    | 2.003   | 94.19207 |
| 15     | 1.066  | 4.98    | 3.002   | 93.49568 |
| 15     | 1.44   | 4.98    | 4.002   | 92.26833 |
| 15     | 1.822  | 4.97    | 4.99    | 90.74387 |

| <b>2; 3.3V Channel</b> (Both 5V and 12V Channels are OFF) |        |         |         |          |
|-----------------------------------------------------------|--------|---------|---------|----------|
| Vin(V)                                                    | Iin(A) | Vout(V) | Iout(A) | Eff.(%)  |
| 15                                                        | 0.004  | 3.38    | 0       | 0        |
| 15                                                        | 0.008  | 3.37    | 0.014   | 39.31667 |
| 15                                                        | 0.017  | 3.356   | 0.051   | 67.12    |
| 15                                                        | 0.03   | 3.346   | 0.102   | 75.84267 |
| 15                                                        | 0.131  | 3.339   | 0.505   | 85.81145 |
| 15                                                        | 0.251  | 3.337   | 1.004   | 88.98667 |
| 15                                                        | 0.488  | 3.335   | 2.003   | 91.2569  |
| 15                                                        | 0.735  | 3.334   | 3.002   | 90.78157 |
| 15                                                        | 0.995  | 3.329   | 4.001   | 89.24174 |
| 15                                                        | 1.264  | 3.32    | 4.99    | 87.37764 |

| <b>3; 12V Channel</b> (Both 5V and 3.3V Channels are OFF) |         |         |          |          |
|-----------------------------------------------------------|---------|---------|----------|----------|
| Vin(V)                                                    | Iin(mA) | Vout(V) | Iout(mA) | Eff.(%)  |
| 5                                                         | 6       | 11.96   | 0        | 0        |
| 5                                                         | 46      | 11.97   | 14       | 72.86087 |
| 5                                                         | 145     | 11.95   | 51       | 84.06207 |
| 5                                                         | 280     | 11.94   | 101      | 86.13857 |
| 5                                                         | 336     | 11.94   | 122      | 86.70714 |
| 5                                                         | 392     | 11.94   | 142      | 86.50408 |
| 5                                                         | 452     | 11.94   | 163      | 86.11593 |
| 5                                                         | 502     | 11.94   | 181      | 86.1012  |
| 5                                                         | 563     | 11.94   | 201      | 85.25542 |





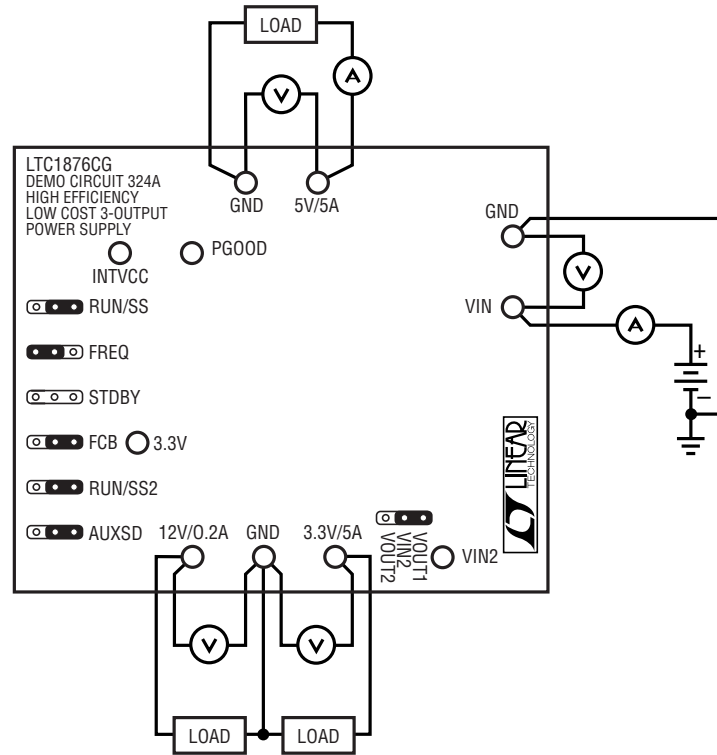
## MEASUREMENT SETUP

The circuit shown in Figure 1 provides three fixed voltages: 5V, 3.3V and 12V, at currents of up to 5A, 5A and 200mA, respectively. Figure 2 illustrates the correct measurement setup to be used to verify the typical numbers found in the Performance Summary table. Small spring clip leads are very convenient for small-signal bench testing but should not be used at the current and impedance levels associated with this switching regulator. Soldered wire connections are required to properly ascertain the performance of this demonstration board. Do not tie the grounds together off the test board.

The six jumpers on the left side of the board are settable as follows: the center pin is connected to ground when the jumper is in the rightmost position. The center pin is connected to a positive bias source when the jumper is in the leftmost position. The jumper below L2 at the lower right side of the board is used to select the input supply for the step-up channel.  $V_{OUT2}$  (3.3V) is selected if this jumper is in the leftmost position and  $V_{OUT1}$  (5V) is selected if it is in the rightmost position. This jumper should be left off when a separate power supply is used through the  $V_{IN2}$  terminal near the jumper. Refer to the Jumper Configuration table for jumper functions.

## QUICK START GUIDE

This demonstration board is easily set up to evaluate the performance of the LTC1876. Please follow the procedure outlined below for proper operation.



**Figure 2. DC324A Test and Measurement Setup**

1. Refer to Figure 2 for board orientation and proper measurement equipment setup.
2. Place the jumpers as shown in the diagram. Temporarily leave the STDBY jumper off.
3. Connect the desired loads between  $V_{OUT1}$ ,  $V_{OUT2}$  and  $V_{OUT3}$  and their closest GND terminals on the board. The loads can be up to 5A for  $V_{OUT1}$  and  $V_{OUT2}$  and 200mA for  $V_{OUT3}$ . Soldered wires should be used when load current exceeds 1A in order to achieve optimum performance.
4. Connect the input power supply to the  $V_{IN}$  and GND terminals on the right edge of the board. Do not increase  $V_{IN}$  over 30V or the MOSFETs may be damaged. The recommended  $V_{IN}$  to start is <7V.

5. Switch on the step-down channel(s) by removing the RUN/SS1 or RUN/SS2 jumpers.
6. Measure  $V_{OUT1}$  and  $V_{OUT2}$  to verify output voltages of  $5.00V \pm 0.10V$  and  $3.30V \pm 0.07V$ , respectively, at load currents of up to 5A each.
7. Connect the jumper below L2 to select the input supply for the step-up channel. Refer to the Measurement Setup section for proper connection. When  $V_{OUT1}$  or  $V_{OUT2}$  is selected, reduce the load level of the selected output below 4A or the total load current of the selected channel may exceed 5A.
8. Switch on the step-up channel by placing the AUXSD jumper in the leftmost position.

Active loads can cause confusing results. Refer to the active load discussion in the Operation section.

#### JUMPER CONFIGURATION

|           | Left                                                | Right                                           | Open                                                  |
|-----------|-----------------------------------------------------|-------------------------------------------------|-------------------------------------------------------|
| RUN/SS    | Over-Current Latch-Off of Channel 1 Defeated        | Channel 1 Shut Off                              | Over-Current Latch-Off of Channel 1 Enabled           |
| FREQ      | 300kHz for Channels 1 and 2                         | 150kHz for Channels 1 and 2                     | 230kHz for Channels 1 and 2                           |
| STDBY     | 5V and 3.3V LDOs Turned On                          | Channels 1 and 2 Shut Off                       | Channels 1 and 2 Released                             |
| FCB       | Discontinuous Operation Enabled at Channels 1 and 2 | Forced Continuous Operation at Channels 1 and 2 | Do Not Leave This Jumper Open                         |
| RUN/SS2   | Over-Current Latch-Off of Channel 2 Defeated        | Channel 2 Shut Off                              | Over-Current Latch-Off of Channel 2 Enabled           |
| AUXSD     | Channel 3 Enabled                                   | Channel 3 Shut Off                              | Channel 3 Shut Off                                    |
| $V_{IN2}$ | $V_{IN2} = V_{OUT2}$ Selected                       | $V_{IN2} = V_{OUT1}$ Selected                   | A Separate Supply Selected through $V_{IN2}$ Terminal |

| Item | Qty | Reference            | Part Description                     | Manufacture / Part #        |
|------|-----|----------------------|--------------------------------------|-----------------------------|
|      |     |                      |                                      |                             |
|      |     |                      |                                      |                             |
|      |     |                      |                                      |                             |
| 1    | 6   | C1,C4,C7,C16,C21,C29 | Capacitor, X7R 0.1uF 10V 20%         | AVX 0603ZC104MAT2A          |
| 2    | 2   | C2,C20               | Capacitor, NPO 27pF 25V 5%           | AVX 06033A270JAT1A          |
| 3    | 2   | C3,C19               | Capacitor, NPO 1000pF 25V 5%         | AVX 06033A102JAT1A          |
| 4    | 1   | C5                   | Capacitor, Alum 33uF 35V 10%         | OSCON 35CV33BS              |
| 5    | 1   | C6                   | Capacitor, Spcl. Poly. 47uF 6.3V 20% | PANASONIC EEFC0J470R        |
| 6    | 1   | C8                   | Capacitor, Tant. 4.7uF 10V 20%       | AVX TACR475M010R            |
| 7    | 1   | C9                   | Capacitor, NPO 220pF 25V 5%          | AVX 06033A221JAT1A          |
| 8    | 1   | C10                  | Capacitor, Spcl. Poly. 56uF 4V 20%   | PANASONIC EEFC0G560R        |
| 9    | 4   | C11,C24,C25,C26      | Capacitor, Y5V 1uF 10V 80%           | AVX 0603ZG105ZAT2A          |
| 10   | 3   | C12,C13,C18          | Capacitor, X7R .01uF 10V 10%         | AVX 0603ZC103KAT1A          |
| 11   | 2   | C14,C17              | Capacitor, NPO 33pF 50V 10%          | AVX 06035A330KAT1A          |
| 12   | 1   | C15                  | Capacitor, NPO 470pF 25V 5%          | AVX 06033A471JAT1A          |
| 13   | 1   | C22                  | Capacitor, Tant. 10uF 20V 20%        | AVX TPSB106M020             |
| 14   | 1   | C23                  | Capacitor, X7R 2.2uF 25V 20%         | AVX 12103C225MAT2A          |
| 15   | 0   | C27 (Optional)       | Capacitor, X7R 10uF 35V 20%          | Taiyo Yuden GMK325BJ106M    |
| 16   | 1   | C28                  | Capacitor, X5R 10uF 25V 20%          | Taiyo Yuden TMK432BJ106MN-T |
| 17   | 2   | C30,C31              | Capacitor, Y5V 10uF 35V 20%          | Taiyo Yuden GMK325F106ZH    |
| 18   | 2   | D1,D4                | Diode, Rectifier, 40V / 40Amp        | Diodes Inc. B140B-13        |
| 19   | 1   | D3                   | Schottky (Comm-Anode)                | Zetex BAT54ATA              |
| 20   | 1   | D5                   | Schottky Diode                       | Central Semi. Corp CMDSH-3  |
| 21   | 6   | XJP1-XJP2,XJP4-XJP7  | SHUNT, .079" CENTER                  | COMM-CON CCIJ2MM-138G       |
| 22   | 7   | JP1-JP7              | Headers, 3 pins                      | Comm-Conn. 2870MS-03G2      |
| 23   | 2   | L2,L1                | Inductor, 4.6uH                      | Sumida CEP123-4R6MC         |
| 24   | 1   | L3                   | Inductor, 10uH                       | TOKO A920CY-100M            |
| 25   | 2   | Q1,Q2                | Mosfet N-Chan. Dual                  | Fairchild FDS6990A          |
| 26   | 2   | R1,R13               | Resistor, LRC 0.010 0.25W 1%         | IRC LRF1206-01-R010-F       |
| 27   | 3   | R3,R9,R14            | Resistor, Chip 1M 0.06W 5%           | AAC CR16-105JM              |
| 28   | 2   | R4,R10               | Resistor, Chip 20K 0.06W 1%          | AAC CR16-2002FM             |
| 29   | 1   | R5                   | Resistor, Chip 105K 0.06W 1%         | AAC CR16-1053FM             |
| 30   | 6   | R6,R17-R21           | Resistor, Chip 10 0.06W 5%           | AAC CR16-100JM              |
| 31   | 1   | R7                   | Resistor, Chip 15K 0.06W 5%          | AAC CR16-153JM              |
| 32   | 1   | R8                   | Resistor, Chip 6.8K 0.06W 5%         | AAC CR16-682JM              |
| 33   | 1   | R11                  | Resistor, Chip 63.4K 0.06W 1%        | AAC CR16-6342FM             |
| 34   | 1   | R12                  | Resistor, Chip 10.2K 0.06W 1%        | AAC CR16-1022FM             |

| <i>Item</i> | <i>Qty</i> | <i>Reference</i> | <i>Part Description</i>                | <i>Manufacture / Part #</i>  |
|-------------|------------|------------------|----------------------------------------|------------------------------|
|             |            |                  |                                        |                              |
|             |            |                  |                                        |                              |
|             |            |                  |                                        |                              |
| 35          | 1          | R15              | Resistor, Chip 86.6K 0.06W 1%          | AAC CR16-8662FM              |
| 36          | 1          | R16              | Resistor, Chip 100K 0.06W 5%           | AAC CR16-104JM               |
| 37          | 11         | TP1-TP11         | Turret, Testpoint                      | Mill Max 2501-2              |
| 38          | 1          | U1               | I.C., LTC1876CG                        | Linear Tech. Corp. LTC1876CG |
| 39          | 4          |                  | Stand-Off Nylon-Hex 4-40 1/4"          | Keystone 1902A               |
| 40          | 4          |                  | Screw,#4-40 1/4"                       | Any                          |
| 41          | 1          |                  | PRINTED CIRCUIT BOARDS                 | DEMO BOARD DC324A            |
| 42          | 1          |                  | STENCIL                                | STENCIL DC324A               |
|             |            |                  |                                        |                              |
|             |            |                  |                                        |                              |
|             |            |                  | <b>Note:please return empty reels.</b> |                              |
|             |            |                  | <b>Thanks.</b>                         |                              |
|             |            |                  |                                        |                              |
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Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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