

DESCRIPTION

Demonstration circuit DC890B along with PScope™ software provides a USB based Windows PC hosted digital data acquisition system supporting CMOS/LVDS output ADCs up to 250Mps. The DC890B must be powered from an external 6VDC ± 0.5 VDC power supply when operating in LVDS mode. When operating in CMOS mode, the external power supply is optional. The Linear Technology supplied PScope evaluation software automatically detects the DC890B and can also detect many of the standard ADC demonstration circuits boards. *The DC890B will not enable LVDS mode unless an external 6.0VDC power source is available.* This system provides for fast and easy performance evaluation of high speed ADCs. DC890B collects up to 256K word samples and then performs

various analyses on the data including calculating SNR, SINAD, THD, SFDR and ENOB. The digitized input, an FFT of the collected data, the primitive wave of the sample set or an IFFT of modified frequency domain data is plotted to a display window to facilitate analyzing distortion products and sources. Figure 1 shows a picture of the DC890B. The DC890B is connected to the ADC demonstration circuit via a 100-pin edge connector, to the PC by a USB A-B cable and to an optional power supply either by a 5mm power plug or optionally by turrets. Figure 2 details the connections.

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

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BOARD PHOTO

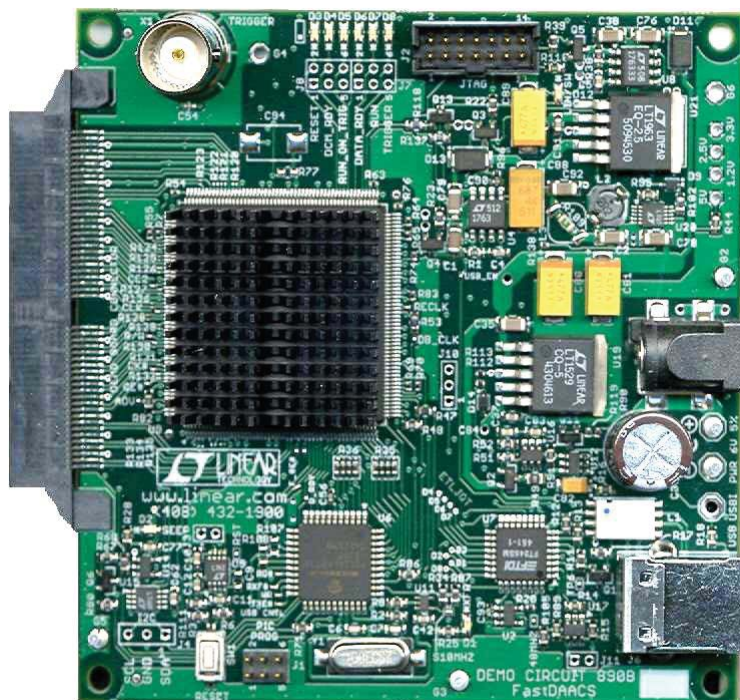


Figure 1. DC890B Board

OPERATING PRINCIPLES

The DC890B is capable of collecting a block of data samples from an ADC demonstration circuit initiated either by an internally generated trigger or an externally supplied 2.5V CMOS level trigger of user selected edge. The external trigger is TTL or CMOS compatible (the trigger line is diode clamped to the 2.5V Rail through a 475Ω resistor).

Refer to the PScope software help for information on the various operating modes and options. The conversion clock to the DC890B is supplied via the ADC demonstration circuit either from an optional on board oscillator if installed or an external signal generator connected to the ADC demonstration circuit.

QUICK START PROCEDURE

To prevent damage to the DC890B, it is important to follow the equipment setup procedure outlined below:

1. Do not plug the DC890B into the PC USB port before running the installation program
2. Download the PScope installation program from <http://www.linear.com/software/>.
3. Run the PScope installation program and follow the on-screen instructions.

NOTE: The PScope evaluation software requires a PC running Windows98, 2000, XP, or later, with an available USB port.

4. Connect the DC890B to the USB port and supply external power to the DC890B, if you will be using the LVDS mode. Do not use a USB cable longer than 2m or the board may not reset properly. (See note in Trouble Shooting section.)
5. Connect only 2.5V CMOS or LVDS output ADC demonstration circuits directly to the DC890B via the 100 pin edge connector. All Linear Technology DC890 compatible demo boards meet these requirements. Apply DC power to the ADC demonstration circuit.
6. Each ADC demonstration board also comes with a quick start guide similar to this one and should be referred to for specific usage details relevant to the demonstration

circuit being evaluated. Please refer to it for proper jumper settings, input power requirements and input signal levels and frequency ranges.

7. Apply an appropriate conversion clock and analog input signal to the ADC demonstration board.
8. ADC board will be automatically detected and configured.
9. Select processing options (the hammer icon) menu and verify that under trigger mode, no trigger wait is selected
10. Enter the exact sample rate in MHz and select the sample size in the provided fields in PScope page 1.

NOTE: Minimum sample rate in LVDS mode is 50MSPS.

11. If the sampled signal is not coherent with the encode clock, select an appropriate windowing function from the pull down menu.
12. Initiate a data collection cycle by clicking the green collect button; it will turn red during the collection cycle. An FFT should appear on the screen along with a plot of the sampled data. Make sure the input level is not over ranging the ADC. See online help for specific guidance on using the PScope software.

QUICK START PROCEDURE

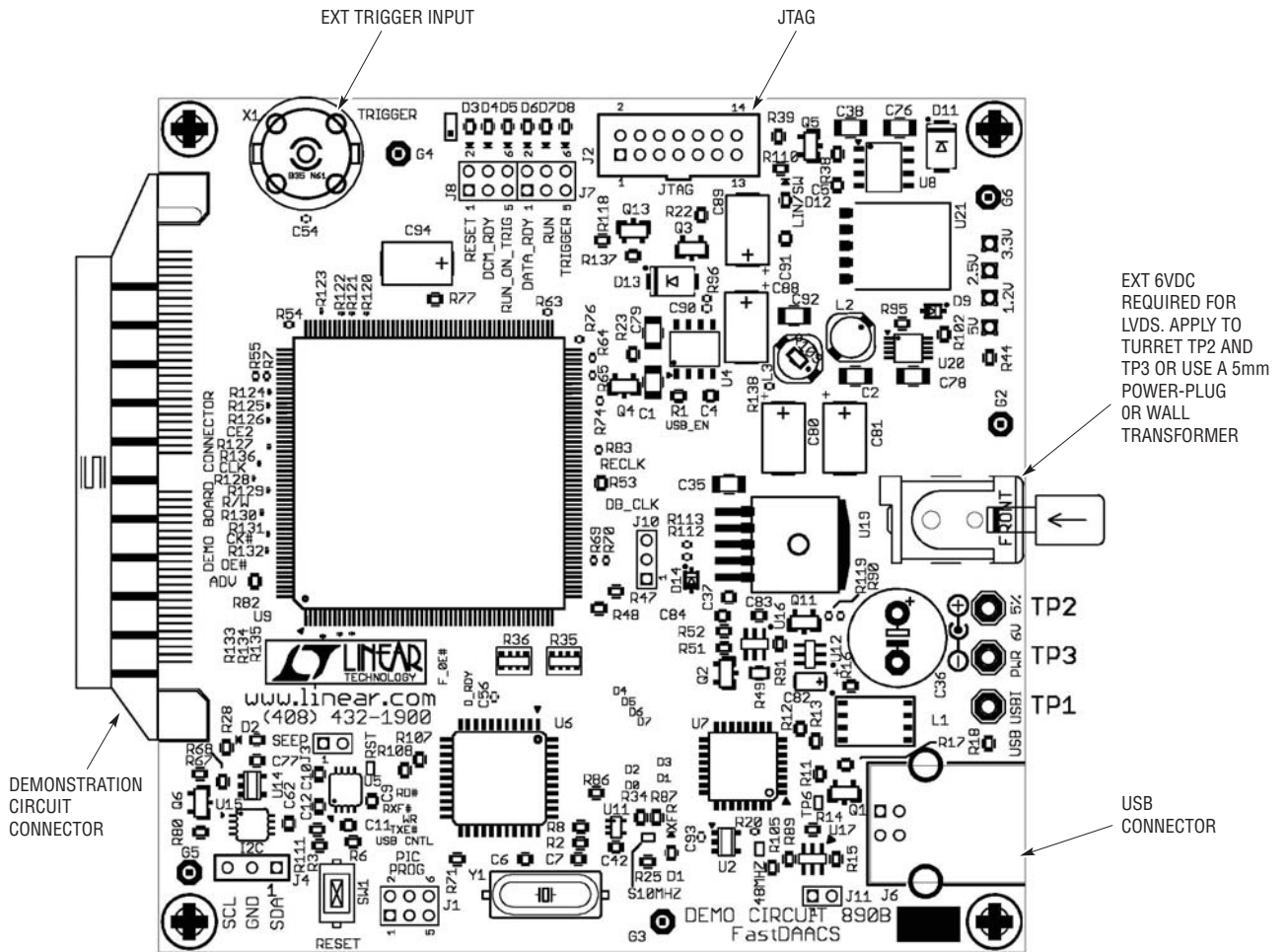


Figure 2. DC890B Basic Connection Locations

USEFUL SOFTWARE TOOLS

The PScope software includes tools for automatic software updates and for quickly retrieving documentation from the world wide web.

NOTE: Adobe Acrobat Reader is required to view the documents and is available at <http://www.adobe.com>.

To update the PScope software (requires an internet connection):

- Choose Update Program from the tools menu.

This automatically updates the main program and drivers for individual demo circuits.

OPTIONAL CONNECTIONS TO THE DC890B

- In CMOS mode the DC890B can operate from the USB power, however in LVDS mode, the Spartan-III FPGA IO ring drivers draw considerable supply current to bias the active LVDS terminations. The DC890B has provisions for a 5mm power plug for an external $6V \pm 0.5V$ supply. The DC890B automatically detects the presence of external power and disables the USB power input.
- X1: The DC890B has provisions for an external trigger input, edge selectable by software. This permits initiating data block capture by an external event.
- J2: A JTAG connector is provided for downloading custom FPGA software to the board. Grounding pin 3 of J2 automatically puts the FPGA into programming mode. User developed code can be loaded into the FPGA without compromising the factory installed code. Jumper pins 4 and 6 of PIC programming connector J1 to disable the microcontroller when using custom FPGA code. Refer to the schematic for further details. **This feature is provided due to customer requests. Development of custom code will not be supported by the factory.**
- J7 and J8 locations (not installed) provide access to six additional FPGA pins for test purposes. These pins also drive LED indicators useful for debug purposes. Xilinx provides logic analysis and data collection features through JTAG via ChipScope.

LED INDICATORS

The DC890B provides system status via eight LEDs:

- LED-1. TRANSFER – Indicates a USB data transfer from the PScope to the PC is in progress.
- LED-2. SEEP – Indicates access of the optional demonstration circuit serial electrically erasable PROM on select demonstration boards. Information in this SEEP permits PScope software to configure the DC890B properly for the device under evaluation using the auto detect demo board feature in the configure/device menu.
- LED-3. RST – Indicates assertion of either a hard or soft reset.
- LED-4. DCM_RDY– In LVDS mode, LED 4 blinks to alert the user that the sample clock is either not present

or outside the required frequency range (F_{IN} must be > 50 MHz). A steady on condition indicates the digital clock module is locked to the input sample clock. In CMOS mode LED 4 functions as a power-on/FPGA programmed Indicator.

- LED-5. RUN ON TRIGGER – Indicates that the board is set to run on trigger (versus halt on trigger mode).
- LED-6. DATA_RDY – Indicates completion of data block acquisition.
- LED-7. RUN – Indicates the board is ARMED to collect a block of data.
- LED-8. TRIGGER – Indicates that a trigger was received and data collection has started.

CIRCUIT DETAILS

A schematic, parts list and parts placement drawings are attached to the end of this quick start guide for reference only.

TROUBLE SHOOTING GUIDE

Problem: DC890B is plugged in, but PScope software still does not recognize DC890B board.

Solution: Assuming that the USB hardware in your computer is operational (try verifying an operational USB port with another USB device such as a USB memory stick, printer or scanner if available.), the likely cause is improper installation of the USB drivers, which results in Windows recognizing the DC890B as an *unknown device*. If this is the case, the problem can be corrected by the following procedure:

- 1) Unplug the DC890B board from the USB port.
- 2) Reinstall the PScope software. **Carefully** following the on-screen instructions. This **may** require a reboot of your computer. The on-screen instructions will inform you if that is the case.
- 3) If the problem persists, please choose *contact software support* from the tools menu for assistance from LTC staff.

Problem: Demonstration circuit software loads properly, but will not run or gives *device not accessible* errors.

Solution: Verify the demonstration circuit is properly powered up and a correct (signal level and frequency) conversion clock is applied. (The DC890B can operate from the USB port power in CMOS mode but will not load the FPGA with the LVDS code unless external power is detected.) Set the correct sample rate for the applied conversion clock as PScope software uses the sample size and rate to determine the watch dog time out period

to reset the DC890B if the USB bus should hang. Refer to the appropriate demonstration circuit quick start guide for details.

Problem: Collected data samples look like noise or appear corrupted.

Solution: Make sure the proper device has been selected in the PScope software, the factory jumper settings are present and for LVDS output demo boards, external power is applied to the DC890B otherwise the captured data will not be properly interpreted.

Problem: PScope reports it cannot reset the DC890B.

Solution: Make sure either a powered USB port is used or external power is supplied. **DO NOT USE A USB CABLE LONGER THAN 2 METERS.** The time delay of a longer USB cable may result in the DC890B intercepting the reset.

Problem: USB Bus appears to be hung.

Solution: As the DC890B is used in a lab environment where power may be inappropriately sequenced, cables unintentionally disconnected etc, some users have reportedly had their USB bus hang. This condition is easily rectified by right clicking properties under my computer ⇒ Hardware ⇒ Device Manager ⇒ and then right clicking on the appropriate USB bus controller and again selecting properties. The device status generally reports that it is working properly. Select the advanced tab. You will notice a refresh button. Device manager has queried the port, and as a result, reset the bus.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	3	C80, C81, C89	CAP, TANT, 470µF, 10V 20% 7343	AVX TPSE477M010R0050
2	0	C94 (OPTION)	CAP, TANT, 470µF, 10V 20% 7343	AVX TPSE477M010R0050
3	0	C88 (OPTION)	CAP, POLY-TA, 1000µF 4V 20% 7343	KEMET T530X108M004ASE006
4	1	C88	CAP, POLY-TA, 680µF 4V 20% 7343	KEMET T520D687M004ASE025
5	1	C36	CAP, 330µF 16V 20PCT	NICHICON UPH1C331MPD6
6	9	C1, C2, C32, C35, C38, C76, C78, C79, C92	CAP, X5R 10µF 6.3V 20% 1206	TAIYO YUDEN JMK316BJ106ML-T
7	1	C82	CAP, TANT, 4.7µF, 10V 20% 3216	AVX TAJA475M010R
8	5	C8, C37, C60, C77, C91	CAP, X5R 1µF 10V 10% 0603	AVX 0603ZD105KAT
9	1	C83	CAP, X5R 0.22µF 16V 20% 0603	AVX 0603YD224MAT
10	15	C11, C12, C27 TO C31, C34, C42, C44, C52, C53, C57, C62, C85	CAP, X7R 0.1µF 16V 10% 0603	AVX 0603YC104KAT
11	43	C13 TO C26, C39, C40, C45 TO C50, C54 TO C56, C58, C59, C61, C63 TO C75, C90, C93	CAP, X5R, 0.1µF, 10V 10% 0402	AVX 0402ZD104KAT
12	1	C43	CAP, X7R 0.047µF 16V 10% 0603	AVX 0603YC473KAT
13	5	C4, C5, C33, C84, C87	CAP, X7R 0.01µF 16V 10% 0603	AVX 0603YC103KAT
14	1	C10	CAP, X7R 2200pF 25V 10% 0603	AVX 06033C222KAT2A
15	0	C9 (OPTION)	CAP, X7R 2200pF 25V 10% 0603	AVX 06033C222KAT2A
16	1	C41	CAP, X7R 1000pF 25V 10% 0603	AVX 06033C102KAT2A
17	0	C86 (OPTION)	CAP, X7R 1000pF 25V 10% 0603	AVX 06033C102KAT2A
18	1	C51	CAP, NPO, 100pF 25V 10% 0603	AVX 06033A101KAT2A
19	3	C3, C6, C7	CAP, NPO 22pF 50V 10% 0603	AVX 06035A220KAT
20	9	D1 TO D8, D12	LED, GRN 0603	LITE ON LTST-C190KGKT
21	1	D10	DIODE, DUAL SCHOTTKY, SOT23	DIODES INC BAT54S-7
22	2	D11, D13	RECTIFIER, GP 1A 50V SMA	DIODE INC S1A -13
23	2	D9, D14	DIODE, GP 200V 200MA SOD323	DIODES INC BAV20WS
24	1	J1	HEADER, 3 × 2, 2mm	COMM CON 2202S-06G2
26	1	J2	HEADER, 2 × 7, 2mm	MOLEX 87831-1420
27	0	J3, J11 (OPTION)	HEADER, 2 × 1, 2mm	COMM CON 3201S-02G2
28	1	J4	HEADER, 3 × 1, 100MIL	SAMTEC TSW-103-26-L-S
29	1	J5	CON, EDGE, 100PIN, 0.063	SAMTEC MEC8-150-02-L-D-EM2
30	1	J6	CON, USB-B, 4 PINS, SINGLE THR HOLE	MILL-MAX 897-30-004-90-000 ALTERNATE 897-43-004-90-000000
31	1	J9	CONNECTOR, POWER 5mm	CUI INC PJ-002A-SMT
32	0	J10 (OPTION)	HEADER, 3 × 1, 2mm	COMM CON 3201S-03G2
33	0	L1	CHOKE, COMMON MODE, QUAD, 5µH	COILCRAFT TDLF4500
34	1	L1 ALTERNATE	CHOKE, COMMON MODE, QUAD, 5µH	COILCRAFT PDLF4500
35	1	L2	IND, PWR, 2.2UH, D52LC	TOKO D52LC #A914BYW-2R2M
36	0	L3 (OPTION)	IND, PWR, 2.2UH, D52LC	TOKO D52LC #A914BYW-2R2M
37	5	Q1, Q6, Q8, Q9, Q12	XSTR, NPN, SOT23	DIODES INC MMBT3904-7
38	2	Q7, Q13	XSTR, PNP, SOT23	DIODES INC MMBT3906-7

DEMO MANUAL DC890B

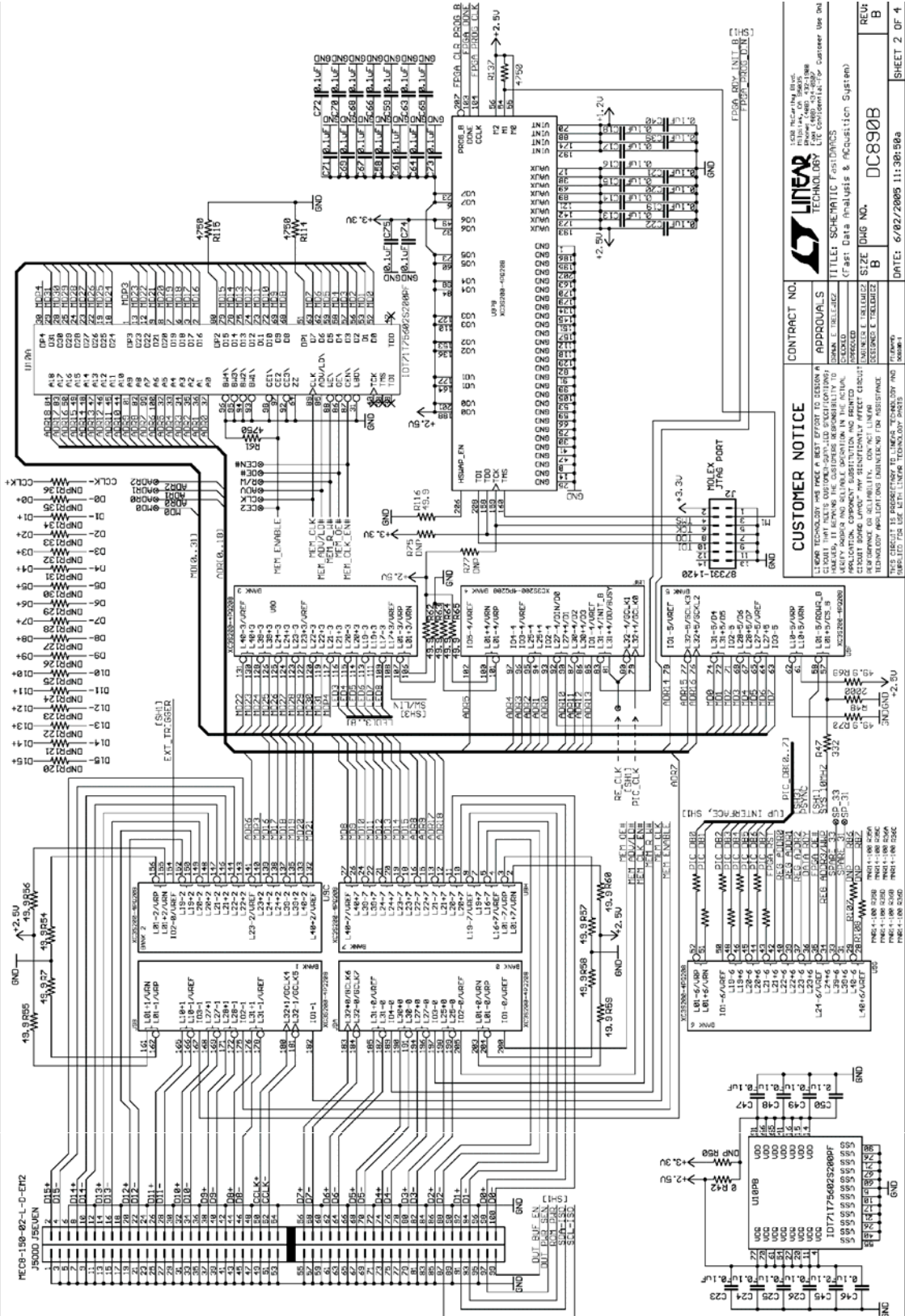
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
39	4	Q2, Q3, Q4, Q5	XSTR, MOSFET, SOT23	VISHAY SI2316DS -T1
		Q2, Q3, Q4, Q5 ALTERNATE	XSTR, MOSFET, SOT23	VISHAY SI2306BDS-T1-E3
40	2	Q10, Q11	XSTR, MOSFET, SOT23	DIODES INC SEMI 2N7002-7
41	1	R102	RES, 2.2M Ω 5% 1/16W 0603	AAC CR16-225JM
42	1	R92	RES, 422k 1% 1/16W 0603	AAC CR16-4223FM
43	1	R95	RES, 324k 1% 1/16W 0603	AAC CR16-3243FM
44	1	R93	RES, 200k 1% 1/16W 0603	AAC CR16-2003FM
45	5	R6, R17, R67, R68, R79	RES, 100k 1% 1/16W 0603	AAC CR16-1003FM
46	1	R94	RES, 16.2k 1% 1/16W 0603	AAC CR16-1622FM
47	1	R3	RES, 14k 1% 1/16W 0603	AAC CR16-1402FM
48	14	R4, R10, R15, R16, R46, R66, R71, R72, R73, R82, R84, R88, R91, R105	RES, 10k 1% 1/16W 0603	AAC CR16-1002FM
49	10	R61, R81, R83, R90, R96, R112 TO R115, R119	RES, 4.75k 1% 1/16W 0402	VISHAY CRCW04024751F
50	6	R21, R103, R104, R117, R118, R137	RES, 4.75k 1% 1/16W 0603	AAC CR16-4751FM
51	0	R77 (OPTION)	RES, 4.75k 1% 1/16W 0603	AAC CR16-4751FM
52	4	R14, R48, R85, R89	RES, 2k 1% 1/16W 0603	AAC CR16-2001FM
53	1	R11	RES, 1.5k 1% 1/16W 0603	AAC CR16-1501FM
54	9	R8, R18, R40, R41, R44, R45, R78, R80, R106	RES, 1k 1% 1/16W 0603	AAC CR16-1001FM
55	0	R75, R107, R108 (OPTION)	RES, 1k 1% 1/16W 0603	AAC CR16-1001FM
56	12	R9, R25 TO 32, R43, R110, R111	RES, 475 Ω 1% 1/16W 0603	AAC CR16-4750FM
57	2	R47, R53	RES, 332 Ω 1% 1/16W 0603	VISHAY CRCW06033320F
58	3	R74, R76, R138	RES, 332 Ω 1% 1/16W 0402	AAC CR05-3320FM
59	5	R1, R2, R19, R38, R52	RES, 100 Ω 1% 1/16W 0603	AAC CR16-1000FM
60	0	R120 TO R136 (OPTION)	RES, 100 Ω 1% 1/20W 0201	VISHAY CRCW0201-101J200RT7
61	17	R7, R20, R24, R54, R55 TO 60, R62 TO 65, R69, R70, R116	RES, 49.9 Ω 1% 1/16 0402	AAC CR05-49R9FM
62	3	R34, R86, R87	RES, 33.2 Ω 1% 1/16W 0603	AAC CR16-33R2FM
63	2	R12, R13	RES, 22.1 Ω 1% 1/16W 0603	AAC CR16-22R1FM
64	4	R22, R23, R39, R51	RES, 10 Ω 5% 1/16W 0603	AAC CR16-100JM
65	5	R97 TO R101	RES, 10 Ω 1% 1/8W 1206	AAC CR18-10R0FM
66	1	R42	RES, 0 Ω JUMPER 0402	VISHAY CRCW04020000ZSTDE
67	0	R50 (OPTION)	RES, 0 Ω JUMPER 0402	VISHAY CRCW04020000ZSTDE
68	1	R109	RES, 0 Ω JUMPER 0805	AAC CJ10-000M
69	1	R49	RES, 0.1 Ω 1% 1/8W 0805	VISHAY WSL0805R1000FEA
70	3	R5, R33, R37	RES, 49.9k 1% 1/16W 0603	AAC CR16-4992FM
71	2	R35, R36	RES 2x4 ARRAY, CHIP, 100 Ω , ISO	ROHM MNR14E0ABJ101
72	1	SW1	SWITCH, LIGHT TOUCH, 2 PINS	PANASONIC EVQPPDA25
73	5	TP2 TO TP3, G2, G3, G5	TURRET	MILL MAX 2308-2

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
74	0	TP1, G4, G6 (OPTION)		
75	1	U17	IC, 93LC46BT-I/OT, SOT23-6	MICROCHIP 93LC46BT-I/OT
76	1	U7	IC, FT245BM, LQFP32 (2rs., PbF)	FUTURE TECH (FTDICHIP) FT245BM
77	1	U10	IDT71T75602S200PF	IDT71T75602S200PF
78	0	U10 (OPTION)	71V2556S200PF	71V2556S200PF
79	1	U19	IC, LT1529CQ-5	LINEAR TECHNOLOGY LT1529CQ-5
80	1	U4	IC, LT1763CS8	LINEAR TECHNOLOGY LT1763CS8
81	1	U8	IC, LT1763CS8-3.3	LINEAR TECHNOLOGY LT1763CS8-3.3
82	1	U5	IC, LTC1726EMS8-2.5	LINEAR TECHNOLOGY LTC1726EMS8-2.5
83	2	U3, U14	IC, LTC1844ES5-3.3	LINEAR TECHNOLOGY LTC1844ES5-3.3
84	1	U21	IC, LDO, 1.5A, DD-5(Q PKG)	LINEAR TECHNOLOGY LT1963EQ-2.5
85	1	U1	IC, LTC2921CGN-3.3	LINEAR TECHNOLOGY LTC2921CGN-3.3
86	1	U16	IC, LTC4210-1CS6	LINEAR TECHNOLOGY LTC4210-1CS6
87	1	U15	IC, LTC4300A-1CMS8	LINEAR TECHNOLOGY LTC4300A-1CMS8
88	1	U12	IC, LTC4410ES6	LINEAR TECHNOLOGY LTC4410ES6
89	1	U2	IC, OSC, SOT23-5	LINEAR TECHNOLOGY LTC6905CS5-96
90	1	U11	IC, NC7SP17P5X	FAIRCHILD, NC7SP17P5X
91	1	U18	IC, FF, DUAL, HC, TSSOP14	PHILIPS, 74HC74PW
92	1	U6	IC, PIC16LF877A-I/PT	MICROCHIP, PIC16LF877A-I/PT
93	1	U9	IC, XC3S200-4PQ208	XILINX, XC3S200-4PQ208C
94	1	U13	IC, SEEPROM, 4M, SO8	ST MICRO, M25P40-VMN6TP
95	1	U20	IC, SWREG, SYNC, BUCK	LINEAR LTC3411EMS
96	1	X1	CONN, BNC 50Ω	CONNEX 112404
97	1	Y1	CRYSTAL, 10MHz, HC49-SMT	ECS INC. ECS-100-18-5P
98	4		STAND OFF, 1/4 × 4 TO 40	MICRO PLASTICS 14HTSP101
99	4		SCREW, 4 TO 40 - 1/4"	SCREW 4-40X1/4PAN PH SS PS
100	0		HEATSINK, BGA (FOR U9)	AAVID/THERMALLOY 374324B00035

SCHEMATIC DIAGRAM



CONTRACT NO.	APPROVALS	DATE: 6/02/2005 11:30:58a
LINEAR TECHNOLOGY INC. 107175602S280P	LINEAR TECHNOLOGY INC. 107175602S280P	DATE: 6/02/2005 11:30:58a
TITLE: SCHEMATIC FASTENINGS	SIZE: B	REV: B
(Fast Data Analysis & Acquisition System)	DC890B	SHEET 2 OF 4

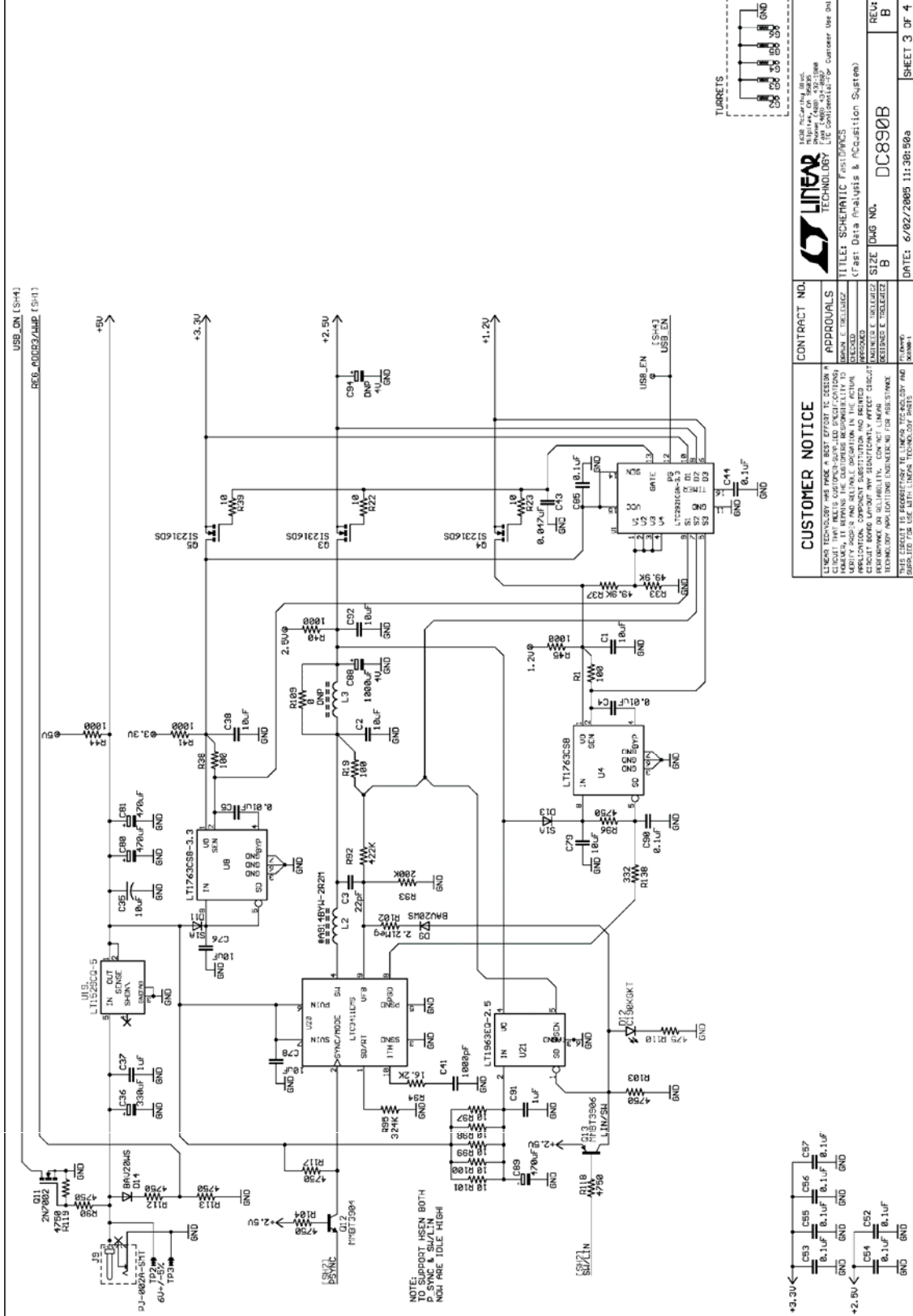
CUSTOMER NOTICE

LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT HELPS OUR CUSTOMERS AVOID EXPENSIVE PROBLEMS. HOWEVER, CUSTOMERS ARE RESPONSIBLE FOR THE FINAL APPLICATION, COMPONENT SUBSTITUTION AND IDENTIFICATION. CUSTOMERS SHOULD VERIFY ANY IDENTIFICATION AFFECTS CIRCUIT PERFORMANCE. LINEAR TECHNOLOGY ASSUMES NO LIABILITY FOR ASSISTANCE.

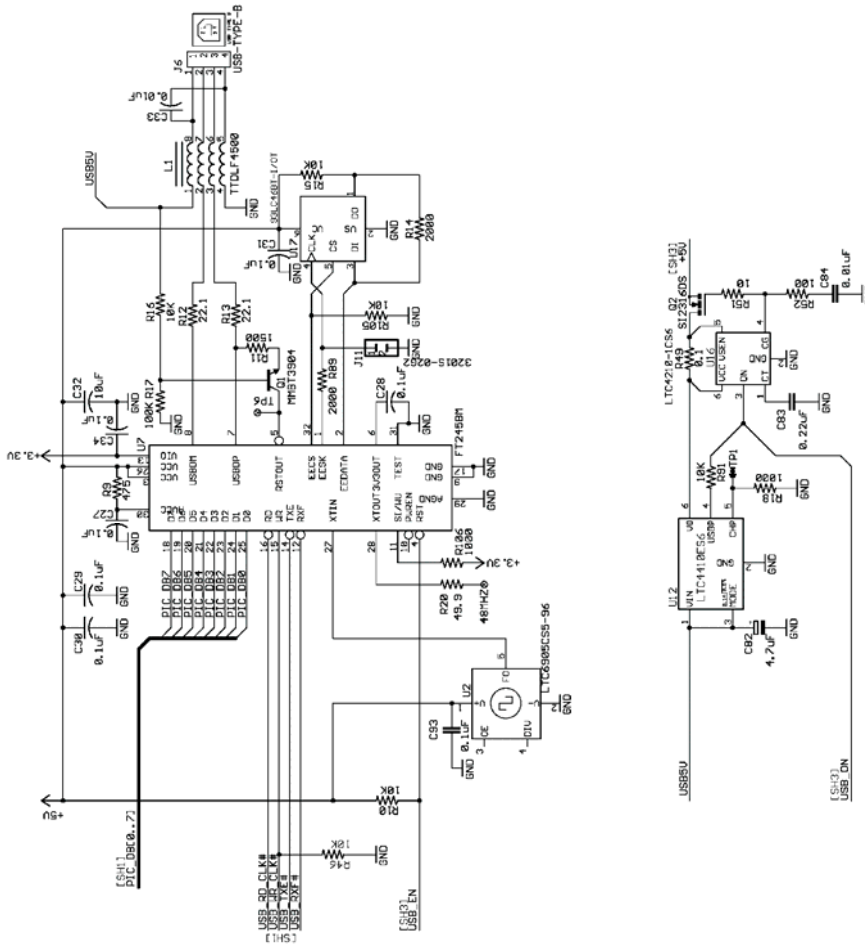
THIS CIRCUIT IS PROTECTED BY LINEAR TECHNOLOGY AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

DEMO MANUAL DC890B

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



CUSTOMER NOTICE		CONTRACT NO.	LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SPECIFIED PERFORMANCE, SPECIFICATIONS, AND RELIABILITY REQUIREMENTS. HOWEVER, LINEAR TECHNOLOGY DOES NOT WARRANT THE PERFORMANCE, APPLICATION, COMPONENT SUBSTITUTION, AND PRINTED CIRCUIT BOARD FABRICATION OF THE CUSTOMER'S PRODUCT. LINEAR TECHNOLOGY ACCEPTS NO LIABILITY FOR ASSISTANCE TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE UNDER THE USE OF LINEAR TECHNOLOGY PARTS.
APPROVALS	DESIGNED	11-390-380B	LINEAR TECHNOLOGY
CHECKED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY
DESIGNED	RELEASED	11-390-380B	LINEAR TECHNOLOGY

LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SPECIFIED PERFORMANCE, SPECIFICATIONS, AND RELIABILITY REQUIREMENTS. HOWEVER, LINEAR TECHNOLOGY DOES NOT WARRANT THE PERFORMANCE, APPLICATION, COMPONENT SUBSTITUTION, AND PRINTED CIRCUIT BOARD FABRICATION OF THE CUSTOMER'S PRODUCT. LINEAR TECHNOLOGY ACCEPTS NO LIABILITY FOR ASSISTANCE TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE UNDER THE USE OF LINEAR TECHNOLOGY PARTS.	LINEAR TECHNOLOGY	11-390-380B	LINEAR TECHNOLOGY
TITLE: SCHEMATIC FOR DC890B	DATE: 6/22/2005 11:39:58a	SIZE: B	DWG NO.: DC890B
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