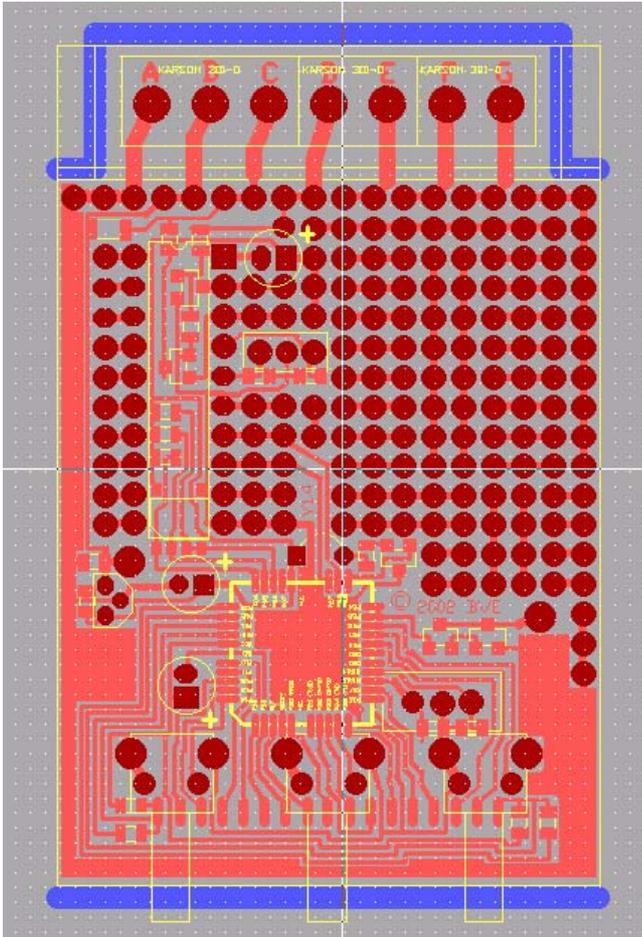


Microtronz 89C4051 Experimenters Board/w Instrument Case

Design and build your own 8051 microprocessor controlled instruments in a stylish UV stabilized and waterproof (front) case. Simple software development with pre-programmed intelligent IC interfaced to handle complex I/O to LCD, key buttons, backlights, alarm buzzer, non-volatile memory, etc. Sample hardware and software designs provided in 8051 assembly, BASIC and C. Make a digital voltmeter and digital thermometer that also output voltage or temperature data on a RS232 serial data line.



EXP-30 PCB and Instrument Case



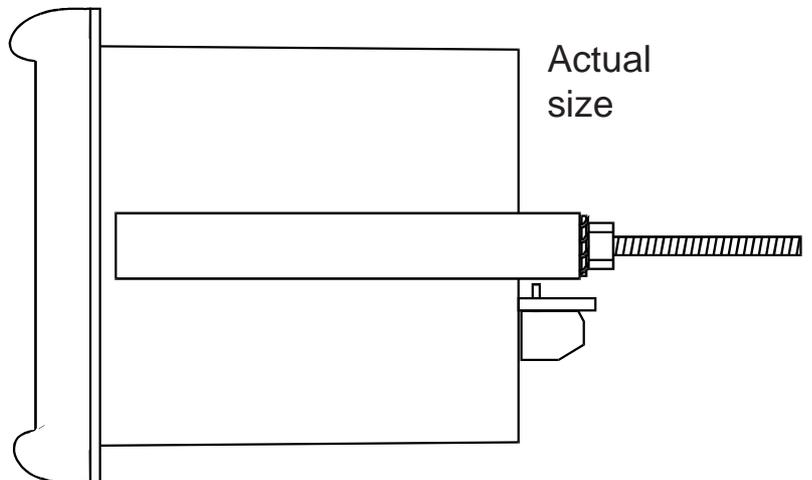
- Stylish waterproof instrument case
- Fully assembled & tested PCB, solder plated, soldermasked & routed with SMD parts in place
- Socketed 89C4051 flash micro included
- On-board 5V regulator IC
- 4 digit 7 segment LCD with dec. point & colon
- Three general purpose key buttons
- Non-volatile memory chip
- Internal backlight LED for night-time viewing
- 85 dB piezo alarm buzzer
- RS232 compatible serial I/O
- Dedicated 11.059Mhz crystal
- 140 pad scratchpad breadboarding area
- 7 position 5mm screw terminal block
- Intelligent IC with LCD, buzzer, LED, NVM, key button debounce/decode software drivers and numerous useful built-in software routines
- Software CD with tested ASM, C and BASIC source code samples and hardware projects
- 8051 Assembler Software
- Working demo 8051 C compiler
- Working demo 8051 BASIC compiler
- Digital voltmeter, thermometer sample code
- Spare parts available separately

EXP-30S \$79.95 complete (standard kit)

EXP-30P \$99.95 professional version

PRG-1 AT89C2051/4051 Programmer \$59.95

Shipping: US\$5.50 world-wide via air parcel post/insured
 Visa, MasterCard and American Express accepted



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 bvdb@microtronz.com

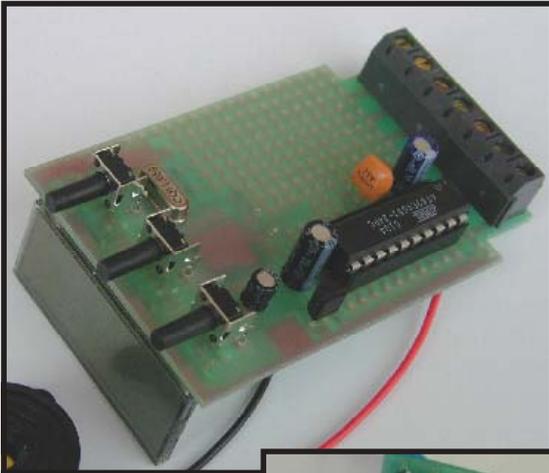
EXP-30 Experimenters Board/Instrument Case

The EXP-30 experimenter's board/instrument is a fully assembled, solder-plated, routed and tested PCB with solder mask and ABS plastic instrument case containing the following:

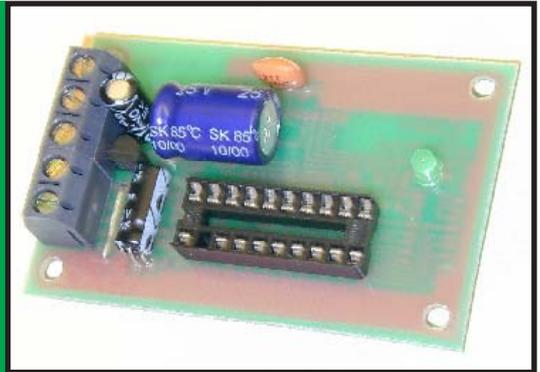
- Professional waterproof front ABS plastic instrument case:
 - a) Stylish UV stabilized instrument case mounts in standard 2-1/8" round hole
 - b) Includes clear front lens with waterproof diecut lexan decal having embossed switch buttons
 - c) Bezel with waterproofing nitrile o-ring
 - d) Mounting bracket for 1/8" to 1" thick bulkheads
 - e) All brass and stainless steel mounting hardware
 - f) Rubber bulkhead gasket
 - g) Buzzer hole on rear
 - h) Easy screw terminal block access
- Socketed Atmel AT89C4051 (pin compatible to AT90S2313 AVR) flash 8 bit microcontroller
- On-board 5V regulator IC
- Transflective seven segment LCD with 4 large digits, decimal point and colon
- Three key buttons
- Non-volatile memory chip (NVM) with 32 or 96 bytes of memory
- Backlight LED for night-time viewing of LCD with 5 levels of brightness
- 85 dB piezo alarm and audible key click buzzer
- RS232 compatible serial I/O
- Dedicated 11.059Mhz resonator
- Scratchpad breadboarding area with 140 predrilled holes and pads for IC's, resistors, capacitors, etc.
- 7 position 5mm screw terminal block for power, ground, and 5 more I/O's for RS-232 I/O and/or additional connections to outside world
- Software CD with sample C-compiler, sample BASIC compiler, assembler, editor, sample C, BASIC and assembly language code for projects
- Pre-programmed IC with independent 11.059Mhz crystal that performs the following functions with simple commands from the 89C4051 microcontroller using two dedicated bidirectional I/O lines:
Standard version EXP-30-STD:
 - a) Intelligent LCD driver with simple and powerful commands
 - b) NVM interface to read/write NVM data (32 bytes)
 - c) 5 level LED backlight controller
 - d) Piezo alarm buzzer control
 - e) Key debounce and key decoding
 - f) Built-in self-test

Optional Professional version EXP-30-PRO contains all the features of the standard version plus:

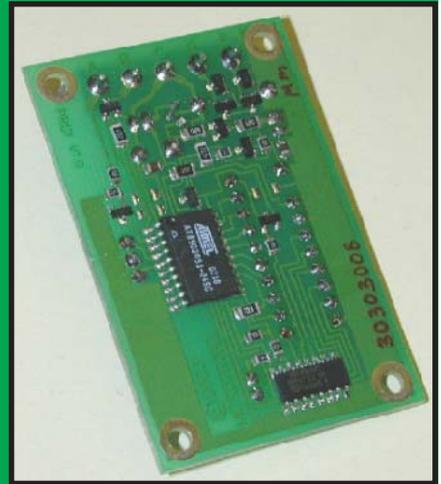
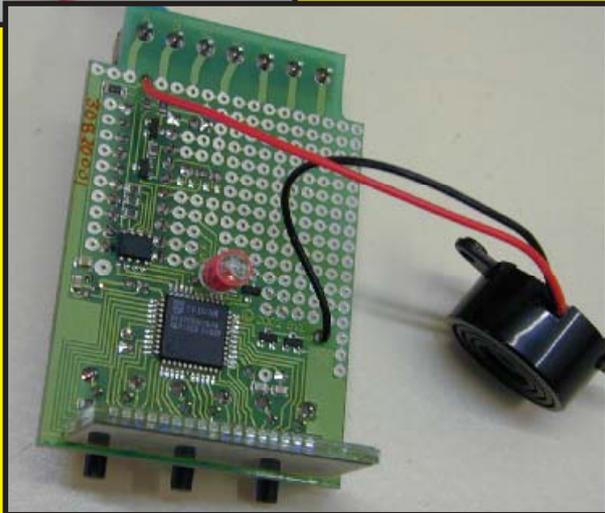
- g) Real-time clock with full software control
- h) 32 bytes of read/write general purpose RAM available in LCD driver
- i) Convert binary 16 bit word to BCD and/or display on LCD
- j) 32 bit unsigned math package
- k) 8 and 16 bit random number generators
- l) Increased NVM read/write space to 96 bytes
- m) Routines to allow use of front panel keys to view/increment/decrement 8/16 bit variables



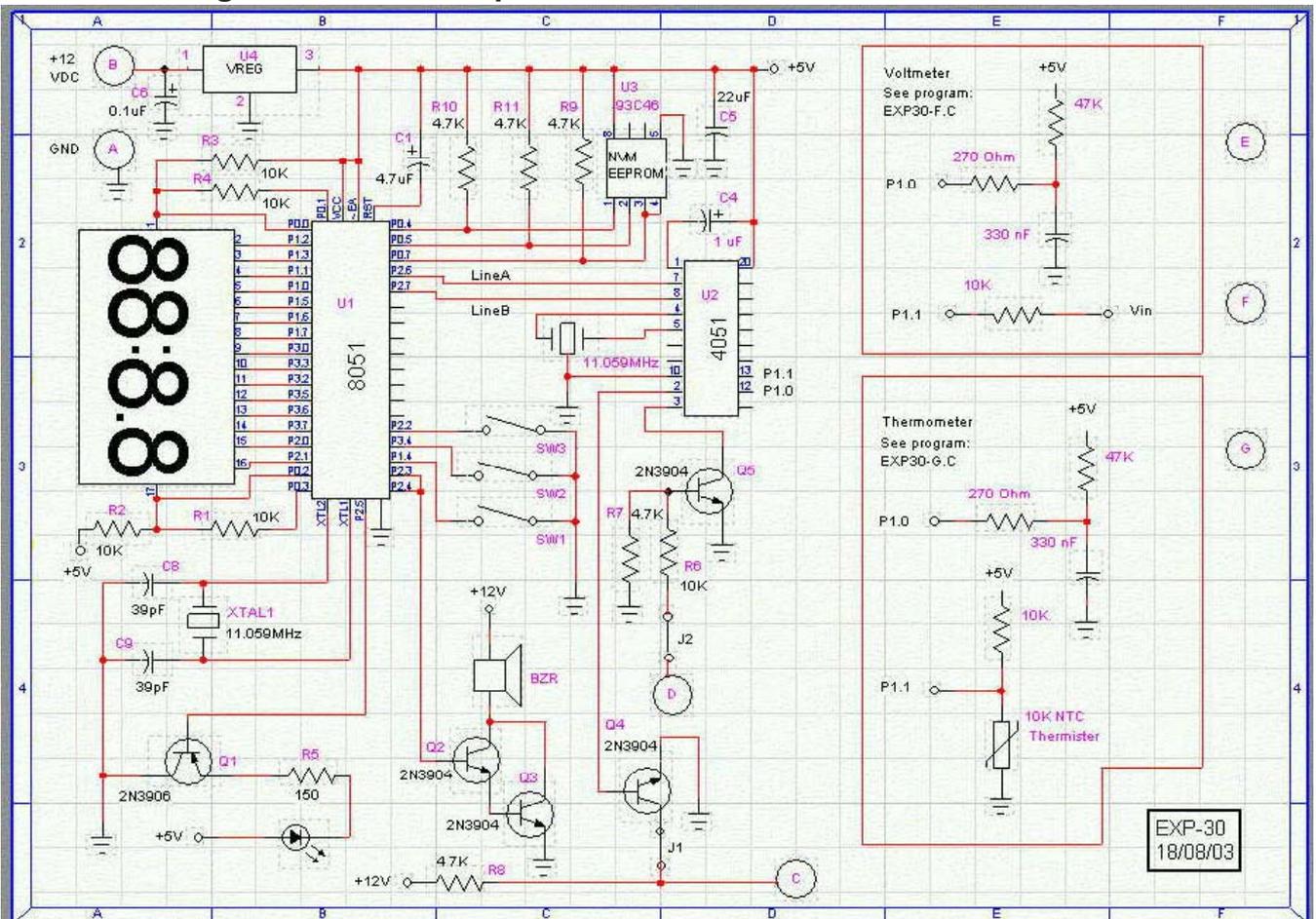
Photos of
PRG-1
AT89C2051/
4051
Programmer
PCB



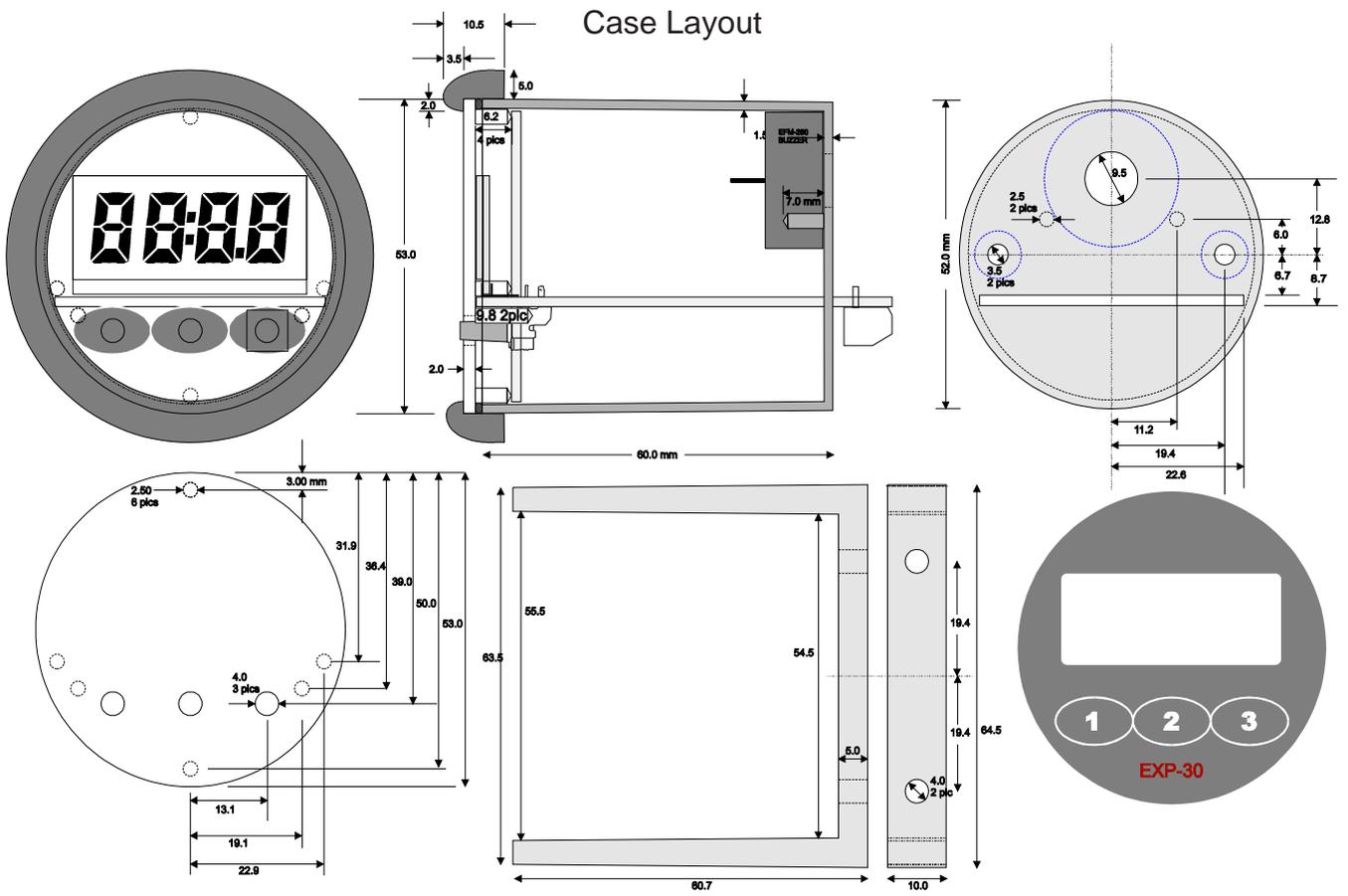
Photos of
EXP-30 PCB



Schematic Diagram of EXP-30 Experimenter's Board



Case Layout



Case Photos



TECHNICAL DATA

The EXP-30 comes in two versions, the EXP-30S (standard version) and the EXP-30P (professional version). The EXP-30S can be upgraded at a later date via an activation code once an upgrade fee has been paid.

The EXP-30 contains two microcomputers - the MASTER and the SLAVE. The MASTER is a socketed flash microcontroller programmed by the user. The SLAVE is pre-programmed with a host of useful software functions and controls the complicated I/O associated with Non Volatile Memory (NVM), LCD driving, key decoding, etc.

The SLAVE is told what functions to perform by the MASTER through a series of simple instructions detailed here.

A) All data from MASTER to SLAVE is sent as:

- 1) One 8 bit INSTRUCTION byte and
- 2) 0, 1, 2 or 4 DATA bytes, depending on INSTRUCTION byte

B) All data from SLAVE to MASTER (only in response to an INSTRUCTION) is sent as 0, 1, 2 or 4 DATA bytes. Note: Not all INSTRUCTIONS cause the SLAVE to send data to the MASTER.

MASTER CONTROL AND TEST INSTRUCTIONS

00h) 00000000b Master Clear

- 1) Disable Buzzer
- 2) Blank DISPLAY (all segments)
- 3) Backlight OFF

01h) 00000001b Master Set

- 1) Enable Keyclicks (when button pushed)
- 2) Enable LCD (all digits show "0")
- 3) Backlight fully ON
- 4) Decimal Point OFF
- 5) Colon OFF

08h) 00001000b Run special Test Program that tests LCD display, Buzzer, Keyswitches, Backlight, Non-Volatile Memory (NVM).

- a) Enable keyclicks, turn backlight full ON, LCD sequentially displays all 0's, 1's, 2's, ..., 9's, 0's, 1's, etc., colon, d.p. OFF until Key 1 pressed, then:
- c) Turn OFF backlights, display all 1's and turn ON colon & d.p. until Key 2 pressed, then:
- d) Display all 2's until Key 3 pressed, then:
- e) When key 3 pressed, save test data to NVM, read back test data and display Err0 and stop if not OK, else display the board's serial number on the LCD.

The Test Program can also be run manually. To start the Test Program manually:

- 1) Remove power from the experimenter's board
- 2) Press and hold down all three keys
- 3) While holding down all three keys, apply power to the board.

LCD CONTROL INSTRUCTIONS

02h)	00000010b	Clear decimal point
03h)	00000011b	Turn decimal point ON
04h)	00000100b	Clear colon
05h)	00000101b	Turn colon ON
06h)	00000110b	Clear all segments OFF (blank display)
07h)	00000111b	Set all segments ON (including colon & D.P.)
1xh)	0001xxxxb	Set LCD Digit 1 <0-15> 0123456789AbCdEF
2xh)	0010xxxxb	Set LCD Digit 2 <0-15> 0123456789AbCdEF
3xh)	0011xxxxb	Set LCD Digit 3 <0-15> 0123456789AbCdEF
4xh)	0100xxxxb	Set LCD Digit 4 <0-15> 0123456789AbCdEF
		Example: 01000100b Makes a “4” show in LCD digit 4 position.
81h)	10000001b	Set segment bits for Digit1
82h)	10000010b	Set segment bits for Digit2
83h)	10000011b	Set segment bits for Digit3
84h)	10000100b	Set segment bits for Digit4
		Followed by one DATA byte 0xxxxxxx where xxxxxxx are 1 or 0 to light/extinguish segment gfedcba.
		Example: 10000100b command to set segment bits for digit 4 01000000b lights “g” segment and makes a “-” show in digit 4 position

BACKLIGHT LED CONTROL INSTRUCTIONS

50h)	01010000b	Turn backlight OFF
51h)	01010001b	Set backlight to level 1
52h)	01010010b	Set backlight to level 2
53h)	01010011b	Set backlight to level 3
54h)	01010100b	Set backlight to level 4 (FULL ON)

BUZZER CONTROL INSTRUCTIONS

60h)	01100000b	Turn OFF buzzer
61h)	01100001b	Beep .01 secs
62h)	01100010b	Beep .02 secs
63h)	01100011b	Beep .05 secs
64h)	01100100b	Beep .10 secs
65h)	01100101b	Beep .20 secs
66h)	01100110b	Beep .50 secs
67h)	01100111b	Beep 1.0 secs
68h)	01101000b	Beep 2.0 secs
69h)	01101001b	Turn ON buzzer
6Ah)	01101010b	Disable automatic Keyclicks
6Bh)	01101011b	Enable automatic Keyclicks

KEYBUTTON STATUS INSTRUCTIONS

- 6Ch) 01101100b Get key release data 0xyzabcd as one byte (binary format). Key(s) x,y,z pressed abcd amount of time. x,y,z. = **1, 2, 3**
- a) abcd=0001b if any key(s) pressed > 0.03 seconds
 - b) abcd=0011b if any key(s) pressed > 0.52 seconds
 - c) abcd=0111b if any key(s) pressed > 2.55 seconds
 - d) abcd=1111b if any key(s) pressed > 10.0 seconds

Example: This command requests the SLAVE to return the key press & release status as a single data byte. The return code will be 00000000b if no keys have been pressed and released since the last request. If one or more keys have been pressed and released then the returned data byte will show which key(s) and for how long (e.g. if the center and rightmost keys were both held down for 3 seconds and then released, the SLAVE will return the keycode: 00110011b when interrogated by the MASTER). This command automatically clears the key status register after a valid key press/release sequence has been sent to MASTER.

- 6Dh) 01101101b Get key press/status data. This command returns a single byte that indicates current key press status but does not require a key to be released.
- 6Eh) 01101110b Clears the key status register to all zeros (except the power-up key memory)
- 6Fh) 01101111b Read Power Up key (one of **1, 2, 3**)
- 01000000b = **1** key
 - 00100000b = **2** key
 - 00010000b = **3** key
 - 00000000b = None

NON-VOLATILE MEMORY (NVM) INSTRUCTIONS

- 0A0h) 10100000b Read databyte from NVM location specified by databyte1 (locations 0-31)
Attempts to read from NVM locations > 31 will result in a value of 0FFh
- 0A1h) 10100001b Write databyte2 to NVM address specified by databyte1(locations 0-31).
Attempts to write to NVM locations > 31 will result in "Err6" and a hardware reset is required to continue (see below). The NVM will allow a minimum of one million writes and unlimited reads from each NVM memory location.

ERROR CODES

The SLAVE performs some error checking and if an error is detected one of the following error codes will be displayed on the LCD:

- Err0 - NVM failed to return correct data during selftest
- Err1 - SLAVE timed out while trying to send data to MASTER (more than 1 second elapsed)
- Err2 - SLAVE timed out while receiving data from MASTER (more than 1/2 second elapsed)
- Err3 - Incorrect upgrade activation code entered
- Err4 - MASTER and SLAVE simultaneously attempted to use communication lines to send data
- Err5 - SLAVE received unknown or unauthorized command from MASTER
- Err6 - Attempt to write to invalid NVM address

OPTIONAL COMMANDS FOR PROFESSIONAL OR UPGRADED VERSION

The following extra commands are available to purchasers of the professional version of the experimenter's board or who have purchased the upgrade and unlocked the extra commands. To upgrade from the standard experimenter's board to the professional version, email the board's serial number and payment (Visa, Mastercard or American Express) of US\$25.00 to:

upgrade@microtronz.com

or FAX/mail the required information to:

MicrotroNZ
35 Keeling Road, #A4
Henderson
New Zealand 1008
Tel: 64-9-838-3331
Fax: 64-9-838-3332

Required information:

Card type
Card number
Expiration date
Name on card
Card billing address
Your daytime telephone number

The serial number for your experimenters board can be viewed by manually running the test program or commanding the test program to run (command 08h, see MASTER CONTROL AND TEST COMMANDS). To manually run the test program, press and hold all three keys on power-up and then press the **1**, **2**, and **3** keys in sequence to display the serial # (4 digit HEX #). When the upgrade fee has been paid, your activation key and instructions on how to activate the upgrade functions will be emailed to you.

CONVERT BINARY WORD TO BCD AND/OR DISPLAY INSTRUCTIONS

0B0h) 10110000b Convert databyte1 (msb), databyte2 (lsb) to BCD and display on LCD Digits 1-4
0B1h) 10110001b Convert databyte1 (msb), databyte2 (lsb) to BCD and return five BCD bytes (msb first, lsb last)
0B2h) 10110010b Convert databyte1 (msb), databyte2 (lsb) to BCD, display on 4 digit LCD and return five BCD bytes (msb first, lsb last)

SLAVE VOLATILE MEMORY (RAM) INSTRUCTIONS

0A6h) 10100110b Read databyte from RAM location specified by databyte1 (0-31)
Attempts to read past memory location 31 returns 0FFh
0A7h) 10100111b Write databyte2 to RAM address specified by databyte1 (0-31)
Attempts to write past memory location 31 will result in "Err6"

RANDOM NUMBER INSTRUCTIONS

0Ah) 00001010b Get 8 bit random number. SLAVE returns 8 bit (one byte) random number to MASTER
0Bh) 00001011b Get 16 bit random number. SLAVE returns 16 bit (two bytes) random number to MASTER

INCREASED NON-VOLATILE MEMORY (NVM) LOCATIONS INSTRUCTIONS

- 0A3h) 10100011b Read databyte from NVM location specified by databyte1 (locations 0-95)
Attempts to read from NVM locations > 95 will result in a value of 0FFh.
There is no limitation on the number of reads from each memory location.
- 0A4h) 10100100b Write databyte2 to NVM address specified by databyte1 (locations 0-95)
Attempts to write past NVM memory location 95 will result in "Err6". Each
NVM location can be written a minimum of one million times.

REAL-TIME CLOCK INSTRUCTIONS (NOTE: The clock starts as soon as power is applied)

- 70h) 01110000b Stop clock
- 71h) 01110001b Clear clock to all 0's
- 72h) 01110010b Start clock running
- 73h) 01110011b Sample clock and send time in Hours, Minutes to LCD
- 74h) 01110100b Sample clock and send Minutes, Seconds to LCD
- 75h) 01110101b Sample clock and report time to MASTER as 4 bytes: Hours, Minutes, Seconds,
Hundreths of seconds
- 76h) 01110110b Get clock calibration byte (0 to 255, 128 = nominal value)
- 7Bh) 01110111b Set clock calibration byte (255 = fastest, 0 = slowest)
- 7Ch) 01111100b Set clock Hours (one byte, 0-23)
- 7Dh) 01111101b Set clock Minutes (one byte, 0-59)
- 7Eh) 01111110b Set clock Seconds (one byte, 0-59)
- 7Fh) 01111111b Set clock Hundreths of Seconds (one byte, 0 to 99)

32 BIT UNSIGNED MATH ROUTINE INSTRUCTIONS

These commands require the MASTER to send a command and 0,2 or 4 databytes to the SLAVE. The SLAVE will perform the command and in many instances return data to the MASTER.

The operations are carried out on a 32 bit Accumulator and a 16 bit operand registers located in the SLAVE called acc32 and buff16. acc32 is divided into four bytes acc32_3, acc32_2, acc32_1 and acc32_0 where acc32_3 is the most significant byte.

- 0C0h) 11000000b Clear 16 bit buff16 to 0's
- 0C1h) 11000001b Clear all 4 bytes of acc32 to 0's
- 0C2h) 11000010b Clear both buff16 and all 4 bytes of acc32 to 0's
- 0C3h) 11000011b Clear only two high bytes of acc32 to 0's
- 0C4h) 11000100b Store two bytes to buff16 (msb, lsb)
- 0C5h) 11000101b Store two bytes to acc32_3, acc32_2 (msb, lsb)
- 0C6h) 11000110b Store two bytes to acc32_1, acc32_0 (msb, lsb)
- 0C7h) 11000111b Store 4 bytes to acc32 (msb, .., lsb)
- 0C8h) 11001000b Add buff16 to acc32
- 0C9h) 11001001b Subtract buff16 from acc32
- 0CAh) 11001010b Multiply buff16 by acc32
- 0CBh) 11001011b Divide buff16 into acc32
- 0CCh) 11001100b Move lower 16 bits of acc32 to buff16
- 0CDh) 11001101b Move buff16 to lower 16 bits of acc32
- 0CEh) 11001110b Convert lower 16 bits of acc32 to BCD and display results on 4 digit LCD
- 0CFh) 11001111b Convert buff16 to BCD and display results on 4 digit LCD

0D0h) 11010000b	Move two bytes to buff16 and add buff16 to acc32
0D1h) 11010001b	Move two bytes to buff16 and subtract buff16 from acc32
0D2h) 11010010b	Move two bytes to buff16 and multiply buff16 by acc32
0D3h) 11010011b	Move two bytes to buff16 and divide buff16 into acc32
0D4h) 11010100b	Send two bytes from buff16 (msb, lsb) to MASTER
0D5h) 11010101b	Send two bytes from acc32_3, acc32_2 (msb, lsb) to MASTER
0D6h) 11010110b	Send two bytes from acc32_1, acc32_0 (msb, lsb) to MASTER
0D7h) 11010111b	Send 4 bytes from acc32 (msb, .., lsb) to MASTER
0D8h) 11011000b	Move two bytes to buff16 and add buff16 to acc32, convert acc32_1 and acc32_0 to BCD and display on 4 digit LCD
0D9h) 11011001b	Move two bytes to buff16 and subtract buff16 from acc32, convert acc32_1 and acc32_0 to BCD and display on 4 digit LCD
0DAh) 11011010b	Move two bytes to buff16 and multiply buff16 by acc32, convert acc32_1 and acc32_0 to BCD and display on 4 digit LCD
0DBh) 11011011b	Move two bytes to buff16 and divide buff16 into acc32, convert acc32_1 and acc32_0 to BCD and display on 4 digit LCD
0DCh) 11011100b	Exchange buff16 and acc32_1, acc32_0

INCREMENT/DECREMENT VARIABLE USING UP/DOWN KEY INSTRUCTIONS

The commands below use the UP and DOWN keys to increment and decrement a variable. The starting value of the variable is sent by the MASTER to the SLAVE after the Increment/Decrement instruction. The variable can be a single 8 bit byte or a 16 bit word. The variable's value is displayed on the 4 digit LCD as four BCD digits with leading zero suppression. The variable scrolls up or down if the **3** or **1** keys are held. The speed at which the variable increments/decrements depends on how long the **3** or **1** keys have been held down. The value of the 8 or 16 bit variable is returned to the MASTER when the user presses the "2" key. Note: The user can turn on the decimal point on the display if desired but this will not affect the returned value of the variable.

0A8h) 11101000b	Receive, display and modify an 8 bit variable. Return the displayed value when the "2" key is pressed. This routine limits the 8 bit variable to between 0 and 255.
0A9h) 11101001b	Receive, display and modify a 16 bit variable. Return the displayed value when the "2" key is pressed. The variable is received/returned in msb, lsb order. This routine limits the 16 bit variable to between 0 and 9999.

Spare Parts List and Pricing

Part #	Description	Price 1-9 (each)	10-49 (each)
EXP-30-STD	Complete with PCB, case, software CD, instructions, samples	US\$79.95	\$60.00
EXP-30-PRO	Complete with PCB, case, software CD, instructions, samples	\$99.95	\$75.00
EXP-30-STD PCB	Complete with PCB, all surface mount components, piezo buzzer, LCD, tactile switches (3), 20 pin IC socket, AT89C4051-24PC, Hi-Brite 3500mc red backlight LED, 7 position 5mm screw terminal block, assembled & tested with buzzer, instructions, no case or software CD	\$65.00	\$50.00
EXP-30-PRO PCB	Complete, as above with pro version software upgrade	\$85.00	\$65.00
LCD	Replacement 7 segment transfective LCD, no instructions	\$6.00	\$4.50
BUZZER	Replacement 85 dB piezo buzzer, 12V	\$3.50	\$2.75
TACTILE SWITCH	Replacement horizontal mount tactile switch, one	\$0.25	\$0.15
AT89C4051-24SC	Replacement flash microcomputer IC, unprogrammed	\$6.00	\$4.50
SCREW TERMINAL	Replacement 7 position, 5mm screw terminal block	\$1.50	\$1.10
CASE	Complete, consisting of white case back, clear lens with diecut EXP-30 decal, black front bezel, white bracket, nitrile o'ring, bulkhead gasket and brass/stainless mounting hardware	\$20.00	\$15.00
BEZEL	Black replacement bezel only	\$3.00	\$2.00
LENS	Clear lens with diecut/embossed EXP-30 decal in place	\$6.00	\$4.50
AT89C2051/4051 PROGRAMMER	Built/Tested 2051/4051 programmer with software. Requires 12V AC or DC and RS232 port to operate. Reads Intel HEX files.	\$59.95	\$49.95

Prices subject to change. Minimum order size US\$20.00, shipping and handling is US\$5.50 minimum via air parcel post. Visa, MasterCard and American Express accepted, no checks. Prices and shipping costs quoted separately for larger orders.

	Qty:	Part #	Price
Name: _____		_____	
Address: _____		_____	
_____		_____	
_____		_____	

Tel: _____			Sub-total _____
Email: _____			Shipping _____
			Total _____
Card # _____ Exp. _____			
Signature _____			

Spare parts only available by direct order from:

Microtronz Ltd.
 35 Keeling Road, #A4
 Henderson, New Zealand 1008
 Tel: 64-9-838-3331
 Fax: 64-9-838-3332

www.microtronz.com
 email: bvdb@microtronz.com