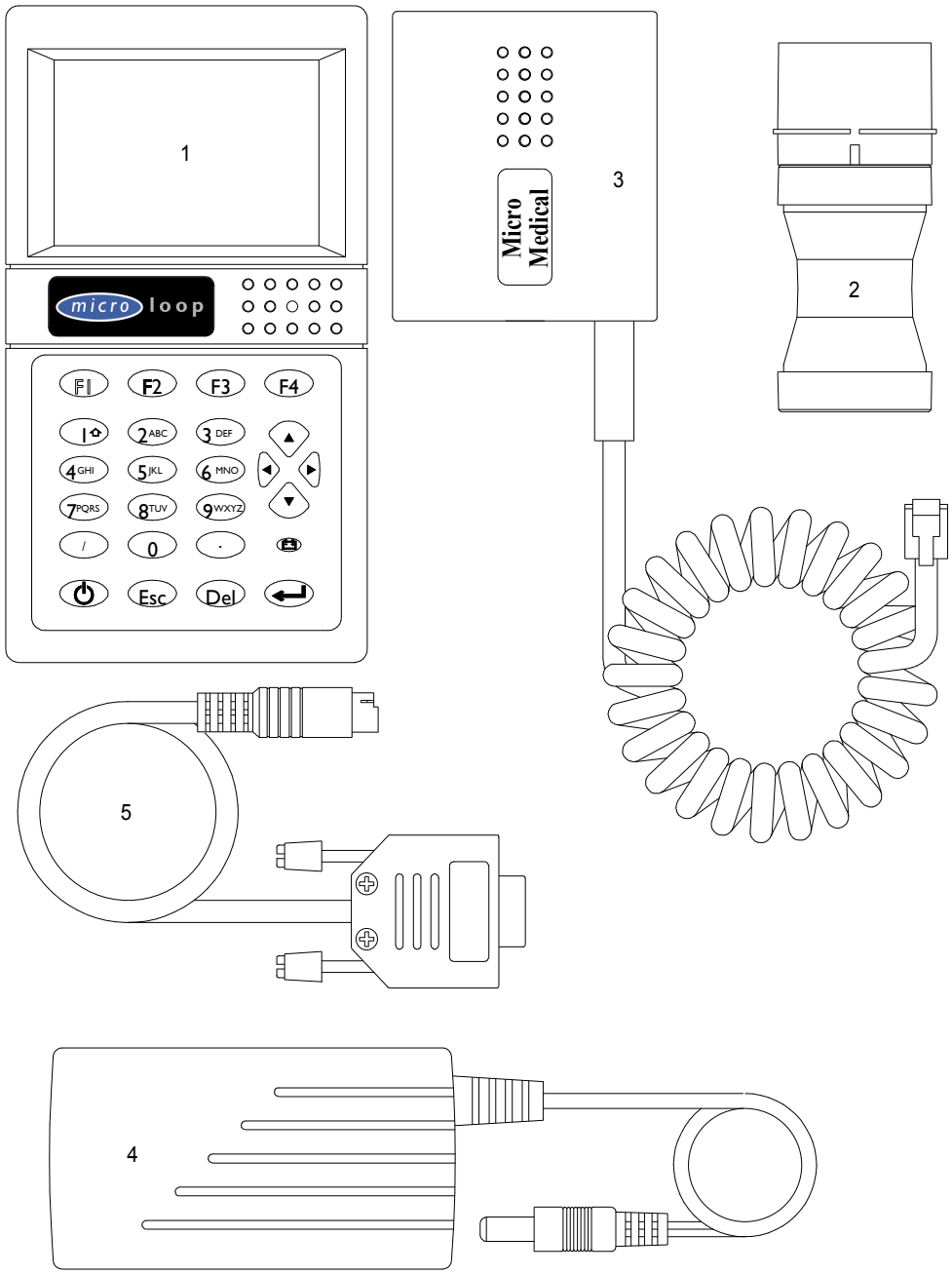
MicroLoop
Service Manual

067-17
Revision 1.0 November 2002

MicroLoop - System Overview (Fig. 1)

The Micro Medical MicroLoop is a data recording spirometer consisting of a microcomputer unit (1) incorporating an LCD graphic display, data entry keypad, RS232 serial interface and all associated circuitry. This is supplied with a digital volume transducer (2), disposable mouthpieces, transducer holder (3) and mains adapter (4). The MicroLoop is powered by internal rechargeable Nickel Cadmium cells or by the mains adapter supplied (4).

When testing a subject the transducer is inserted into the holder which is plugged into the microcomputer unit. The digital volume transducer is used to measure the subjects expired flow and volume in accordance with the operating manual.

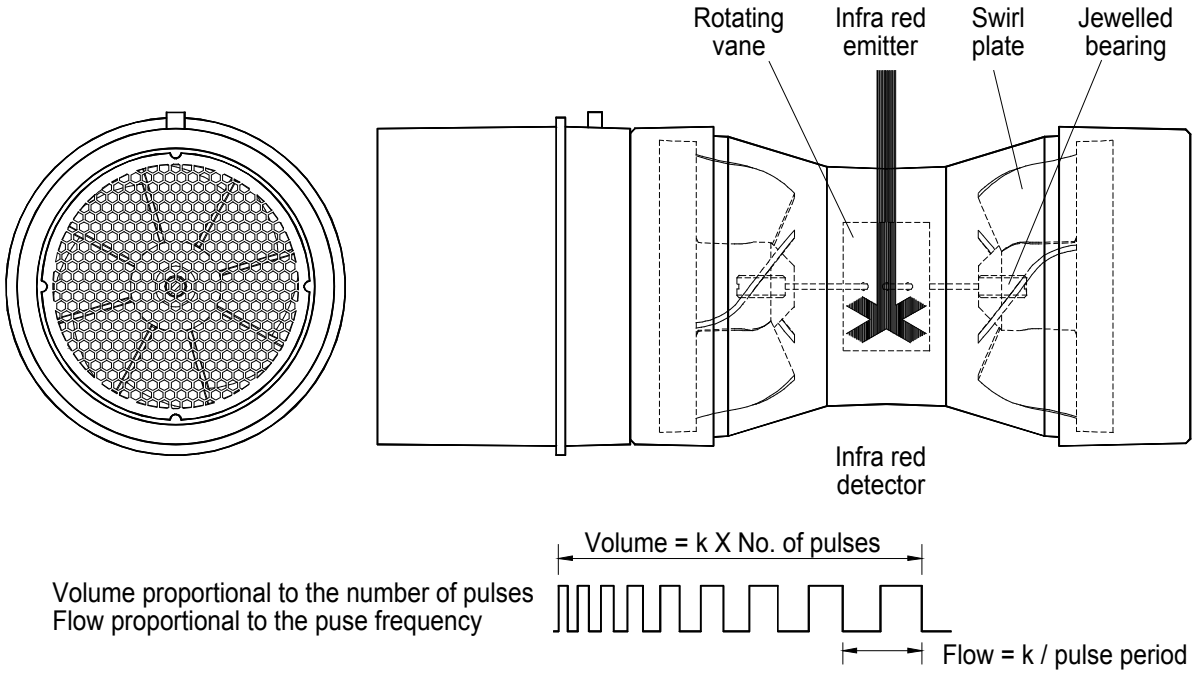


Transducer (Fig. 2)

The Micro Medical digital volume transducer consists of an acrylic tube with a vane positioned between two swirl plates. The low inertia vane is attached to a stainless steel pivot which is free to rotate on two jewelled bearings mounted at the centre of the swirl plates. As air is passed through the transducer a vortex is created by the swirl plates which causes the vane to rotate in a direction dependant upon the direction of air flow. The number of rotations is proportional to the volume of air passed through the transducer and the frequency of rotation is proportional to the flow rate. The transducer housing consists of a main body which contains a pair of light emitting diodes (LED's) and phototransistors. The transducer is fixed to the mouthpiece holder which pushes into the main body and is captured by an "O" ring seal. The LED's produce infra red beams which are interrupted by the vane twice per revolution. This interruption is sensed by the phototransistors. The output from the collector of each phototransistor will be a square wave with a phase difference between the two of + or - 90 degrees depending upon the direction of flow.

There is no routine maintenance required for the transducer other than cleaning according to the instructions in the operating manual.

Micro Medical Digital Volume Transducer



Microcomputer Unit
(Refer to drawings 067-01 – 067-05, 067-11, and 067-12)

The microprocessor control circuit carries out the spirometry routines, monitors the transducer pulses and keypad, and drives the display under the control of the program module.
The drawing 067-01 is a hierarchical block diagram showing the connections of the sub-sections. The rest of the drawings are sub-sections and are described in detail below.

Micro controller (067-02).

U9 is a Hitachi HD64F2318 16 bit microprocessor with 256K of flash memory and 8K of Ram. The system clock is supplied by 20MHz crystal (X2). There is also 512 Kbyte (U7) of external Ram used for running a module and storing variable data. The internal flash is used for the boot software, kernel and the base module. The kernel handles the low level interface to display, keyboard etc. and the base module runs on start-up and gives a choice of which module needs to be executed.

The modules are stored in the external 8 Mbyte Flash PROM (U5). The kernel also has a flash filing system which keeps track of all the files in the external Flash PROM. The files can be an executable module or spirometry or other module data. The filing system is similar to the old PC Dos filing system.

U15 is just used to control the access to the flash device.

The speaker J5 is directly connected to the Port pins and the pins are toggled at 1 KHz to generate the buzzing sound.

U9 is used for enabling the internal flash to be overwritten. If a new kernel is downloaded, the flash is enabled and data transferred.

U10 is the reset controller, which holds the reset line low for 350 ms on power up. This ensures that the supply has stabilised before the micro starts.

TR3 is used by the micro to hold the power supply ON whilst it is writing to the filing system. This is to ensure that data is not corrupted when it is writing and the power is turned off.

TR4 allows the micro to turn off the power and switch off the unit. This is normally done when the unit is left on for a long period of time. To preserve the battery, it turns it off.

Memory Map

0x000000	-	0x040000	256K	Internal Flash
0x400000	-	0x480000	512K	External Ram for modules
0x800000				Flash Prom (Single address used)
0xC00000				Display Controller
0xFFDC00 –		0xFFFBFF	8K	Internal Ram – stack.

Keypad interface (067 – 03)

The 26 keypad switches are arranged in a 5 X 5 matrix and a separate On/Off key. When the keypad is being read by the processor the 5 columns are sequentially driven low by the port lines PE0 – PE4. The state of the 5 rows is read by the port P40 – P44. The diodes in the keypad PCB isolate the outputs from the Port to ensure that a high current will not flow from an output set high to one set low if two keys are pressed simultaneously. The ON/OFF key is connected to the power control circuitry described in the **Power Supply** section.
Resistor RN1 ensures that the keys which are not pressed are read as high.

Serial interface (067-04)

The uC communicates with the PC or the printer via an RS232 serial interface at 38,4 Kbits per sec baud rate, with 8 bits data, 1 stop bit and no parity. U6 converts the RS232 signal to a logic signal of 3.3V. The uC has two inbuilt serial controllers, SCI0 and SCI1. SCI0 is used for synchronous data transfer whilst SCI1 is used in asynchronous mode for RS232.

Real Time Clock

U3 is a Xicor X1243 real time clock with 2Kbyte of EEPROM. It operates at 32.768 Khz and is powered by the lithium battery. The device requires a very small amount of power during standby mode and as the unit will never drain the battery out, this should be sufficient to keep the clock going for a long period of time before recharging. The clock is set by the processor during the factory set-up and should not require any further adjustment. The date and time can be changed from the system menu.

The interface to the clock is via a I2C bus. The uC does not have a dedicated I2C bus, so two port lines (P20 – P21) are used under software to emulate the bus.

The EEPROM is used for storing the calibration value and other system data. If the device is ever replaced, the unit will have to be reconfigured and recalibrated.

Temperature Sensor

U20 is a Dallas DS18S20 temperature sensor operating on their one wire bus protocol. It has an accuracy of 0.5 degree centigrade. A port line P23 is used under software to emulate the one wire bus.

The ambient temperature reading is used for adjusting inspiratory flow at ambient temperature to respective flow at body temperature.

Transducer interface (067-05)

The supply to the two series LEDs inside the transducer housing is provided through TR1 which is switched on or off by TR2. This is controlled by port pin P26 of the processor and is only turned on during a spirometry manoeuvre to conserve power. However, power is supplied to the transducer through D1 continuously when the mains adapter is connected. The same line is used for powering the Rint transducer and it helps to have it on to charge the transducer battery.
Inside the transducer housing the two phototransistors used to detect the interrupted infra-red beam are in open collector configuration. The collectors are connected to pins 2 and 3 of SK2. The pull up resistor for the two phototransistors is provided by R1 and R2
The signal from the phototransistor is applied to the pulse timing input of the processor (P16) after being squared up by the action of the Schmitt inverters U1. The signal from the second phototransistor, after conditioning (U2) is applied to a D type latch and a clock by the first phototransistor to determine the direction of the turbine. The direction signal is fed to uC via port P17. The rising edge of the signal applied to P16 causes an interrupt to be generated in the processor. This interrupt is processed by incrementing a pulse count, timing the period since the last pulse and by reading the state of P17. The pulse count is used to determine the volume passed through the transducer since the start of the test and the pulse period is used to determine the flow at each volume increment.

Display (067-11)

The display is a high resolution custom graphic 240 by 120 dot LCD. It is controlled by an Epson SED1335 display controller (U16) which directly interface to the uC. The display controller timing is generated by a 10 MHz crystal (X3). U19 is a 32K byte RAM to hold the display data.

The LCD display is based on four planes, each requiring different plane voltage. It is biased by 22 V generated by DC-DC controller U17. VR1 varies this voltage which in turn changes the contrast. At dark level, the bias voltage is typically 22.6V and the plane voltages are 20.9V, 19.2V, 3.5V and 1.7V. Of course, they would be slightly different for different contrast level. The plane voltages are generated by resistor ratio dividers (R12, R13, R25, R14, R17) and buffered by quad Op-amps U18.
J2 is a connector to the display.

Power Supply (067-12)

The power to the system is either supplied by the 3.9V lithium battery or from an external 9V DC regulated power supply. If the external supply is connected, then TR5 is switched off and the battery is not used. R32 ensures that the battery is trickle charged at all times.

The on/off key is conditioned via U12 and applied to set/reset D type flip flop (U11). On every key press, the flip flop toggles between the on and off state. In the On state, TR7 is switched on, switching on TR6. The on state can be held by MC_ON- line from the uC whilst it is saving data in the Flash PROM. The uC can also switch the power off by means of the MC_OFF- line which resets U11.

U14 is a DC-DC converter with an input range of 0.9V to 10V and an output of 3.3 volts to power the unit. Since the range is up to 10V only, care should be taken not to use any other external power supply, as most of them are unregulated and could output 12V for a 9V unregulated supply.

U14 is another DC-DC converter with an output of 9V. This higher supply is used for powering the sensor LEDs and also to power the Rint transducer.

R28 and R31 divide the unregulated voltage to a third and are applied to the A/D converter of the uC. The uC continuously examines the reading and gives a battery low or battery dead warning message. From the reading the uC can also deduce that the external supply is connected, so it can turn itself off if the unit is left on for a long time.

Inductors L1 and L2 are placed for EMC filtering and D5 protects the unit from reverse polarity power supply

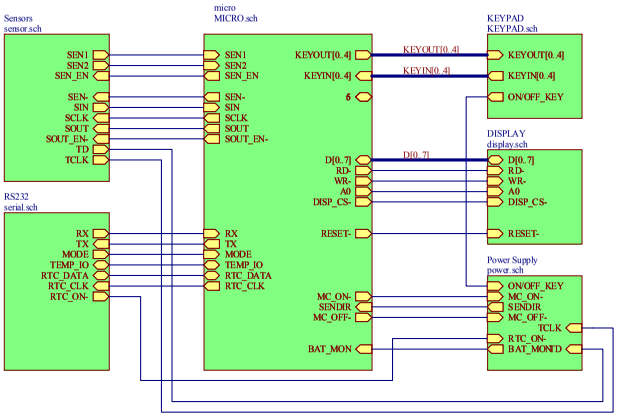
Drawing No.	067-00	Date 12/07/02
Revision No. 1.3		Page: 1 OF 3
Designation	Part No.	Description.
U1	BU4S584	Rohm individual CMOS Schmitt invertor, SOT23-5 package
U2	BU4S584	Rohm individual CMOS Schmitt invertor, SOT23-5 package
U3	X1243S8	Xicor clock calander with 256 X 8 bit RAM, SO-8 package
U4	MAX4544EUT-T	Maxim SPDT analogue switch, SOT23-6 package
U5	K9F6408U0A-TCB0	Samsung 8M X 8 bit FLASH memory, TSOP44/40 package
U6	MAX3221CAE	Maxim RS232 transceiver, SSOP16 package
U7	K6T4008V1C-BB70	Samsung 512k X 8 bit CMOS static RAM, SOL32/525 package
U8	BU4S11	Rohm individual CMOS gate, SOT23-5 package
U9	HD64F2318VTE25	Hitachi H8S/2318 microcontroller, TQFP100 package
U10	MAX824TEXK-T	Maxim power monitor, SOT23-5 package
U11	4013	CMOS Dual D Type flip flop, SO-14 package
U12	4093	CMOS Quad NAND Schmitt input gate, SO-14 package
U13	LT1613CS5	Linear Technology DC/DC convertor, SOT23-5 package
U14	LT1613CS5	Linear Technology DC/DC convertor, SOT23-5 package
U15	74LCX32	Quad 2-input OR gate
U16	SED1335FOB	Display driver
U17	LT1613CS5	Linear Technology DC/DC convertor, SOT23-5 package
U18	LM324	Quad surface mount op-amp
U19	GM76C256CLLFW-55-T/R	Gold Star 32K X 8 bit CMOS static RAM, 28 pin SOP package
U20	DS18S20	Dallas semiconductor digital thermometer, TO-92B package
R1		4.7K resistor 1%, 0805 package
R2		4.7K resistor 1%, 0805 package
R3		4.7K resistor 1%, 0805 package
R4		100K resistor 1%, 0805 package
R5		10M resistor 5%, 0805 package
R6		100K resistor 1%, 0805 package
R7		100K resistor 1%, 0805 package
R8		220K resistor 1%, 0805 package
R9		100K resistor 1%, 0805 package
R10		10K resistor 1%, 0805 package
R11		4.7K resistor 1%, 0805 package
R12		10K resistor 1%, 0805 package
R13		10K resistor 1%, 0805 package
R14		10K resistor 1%, 0805 package
R15		100K resistor 1%, 0805 package
R16		100K resistor 1%, 0805 package
R17		10K resistor 1%, 0805 package
R18		10K resistor 1%, 0805 package
R19		100K resistor 1%, 0805 package
R20		100K resistor 1%, 0805 package
R21		10 ohm resistor 1%, 0805 package
R22		1K resistor 1%, 0805 package
R23		150K resistor 1%, 0805 package
R24		68K resistor 1%, 0805 package
R25		91K resistor 1%, 0805 package
R26		100 ohm resistor 1%, 0805 package

Parts List For: MicroLoop MK6

Drawing No.	067-00	Date 12/07/02
Revision No. 1.3		Page: 2 OF 3
Designation	Part No.	Description.
R27		82K resistor 1%, 0805 package
R28		200K resistor 1%, 0805 package
R29		39K resistor 1%, 0805 package
R30		13K resistor 1%, 0805 package
R31		100K resistor 1%, 0805 package
R32	337-729 (F)	82 ohm 1 watt resistor, axial package
R33		100K resistor 1%, 0805 package
R34		100K resistor 1%, 0805 package
R35		10K resistor 1%, 0805 package
R36		10K resistor 1%, 0805 package
R37		1K resistor 1%, 0805 package
R38		1K resistor 1%, 0805 package
RN1	107-048 (F)	6 pin, 5 commoned 100K SIL network
VR1	T18 S/I S/B S/T 20KA	Piher 20K linear potentiometer
C1		22pF Philips or AVX ceramic, 0805 package
C2		47pF Philips or AVX ceramic, 0805 package
C3		1nF Philips or AVX ceramic, 0805 package
C4		1nF Philips or AVX ceramic, 0805 package
C5		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C6		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C7		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C8		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C9		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C10	197-324 (F)	47uF/16v Surface mount Tantalum
C11		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C12		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C13		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C14		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C15		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C16		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C17		33pF Philips or AVX ceramic, X7R dielectric, 0805 package
C18		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C19		33pF Philips or AVX ceramic, X7R dielectric, 0805 package
C20		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C21		100nF Philips or AVX ceramic, X7R dielectric, 0805 package
C22		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C23	197-324 (F)	47uF/16v Surface mount Tantalum
C24		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C25		100nF Philips or AVX ceramic, 0805 package
C26	301-8544 (F)	33uF/16v Surface mount Tantalum
C27	301-8544 (F)	33uF/16v Surface mount Tantalum
C28	301-8544 (F)	33uF/16v Surface mount Tantalum
C29		100nF Philips or AVX ceramic, 0805 package
C30		100nF Philips or AVX ceramic, 0805 package
C31	301-7000 (F)	100uF/16v
C32		100nF Philips or AVX ceramic, 0805 package
C33	301-8593 (F)	47uF/25v Surface mount Tantalum
C34	301-8544 (F)	33uF/16v Surface mount Tantalum

Parts List For: MicroLoop MK6

Drawing No.	067-00	Date 12/07/02
Revision No. 1.3		Page: 3 OF 3
Designation	Part No.	Description.
C35		10pF Philips or AVX ceramic, 0805 package
C36		10pF Philips or AVX ceramic, 0805 package
C37		100nF Philips or AVX ceramic, 0805 package
C38		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C39		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C40		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C41		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C42		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
C43		1uF Philips or AVX ceramic, X7R dielectric, 0805 package
TR1	DTB113EK	Rohm PNP digital transistor, SOT-23 package
TR2	DTC114EK	Rohm NPN digital transistor, SOT-23 package
TR3	DTC114EK	Rohm NPN digital transistor, SOT-23 package
TR4	DTC114EK	Rohm NPN digital transistor, SOT-23 package
TR5	ZXM62P02E6	P channel MOSFET SOT23-6 package
TR6	ZXM62P02E6	P channel MOSFET SOT23-6 package
TR7	FMMT491	Zetex NPN Transistor SOT-23 package
D1	ZHCS1000	Zetex Schottky diode, SOT-23 package
D2	ZHCS1000	Zetex Schottky diode, SOT-23 package
D3	ZHCS1000	Zetex Schottky diode, SOT-23 package
D4	ZHCS1000	Zetex Schottky diode, SOT-23 package
D5	ZHCS1000	Zetex Schottky diode, SOT-23 package
D6	U1JC44	Toshiba 1A diode
D7	ZHCS1000	Zetex Schottky diode, SOT-23 package
L1	NLFC453232-3R3M	3.3uH inductor, 1210 package
L2	NLFC453232-3R3M	3.3uH inductor, 1210 package
L3	353-1340 (F)	22uH inductor, 1210 package
L4	353-1340 (F)	22uH inductor, 1210 package
L5	353-1340 (F)	22uH inductor, 1210 package
L6	353-1340 (F)	22uH inductor, 1210 package
F1	MICROSMD035-2	Tyco 700mA Polyswitch
DISPLAY	LTA75R227J	Nan Ya 240 X 160 graphic display
J1	95001-2661	Molex 6 way data socket
J2	18FMN-BMTTN-TF	18 way 1mm pitch cable connector from JST
J3	MDS4	4 way mini DIN socket
J4	14FMN-BMTTN-TF	14 way 1mm pitch cable connector from JST
J5		2 way 0.1" pitch pin header
J6		2.5mm DC power socket from G.English
J7		3 way 0.1" pitch pin header
BAT1	B2B-PH-K-S	2 way PCB socket from JST
SPKR	PKM35-4A0	Murata piezo ceramic sounder
X1	571-672 (F)	32.768 KHz crystal, WATCH package
X2		20MHz crystal, HC49/4H package
X3	485-081 (F)	10MHz crystal
	067-09	Sanyo NI CAD battery pack
		M1.7 X 3mm screw
		M1.7 plain washer
	067-15	14 way ribbon cable for keypad
	067-13	PCB Iss 1



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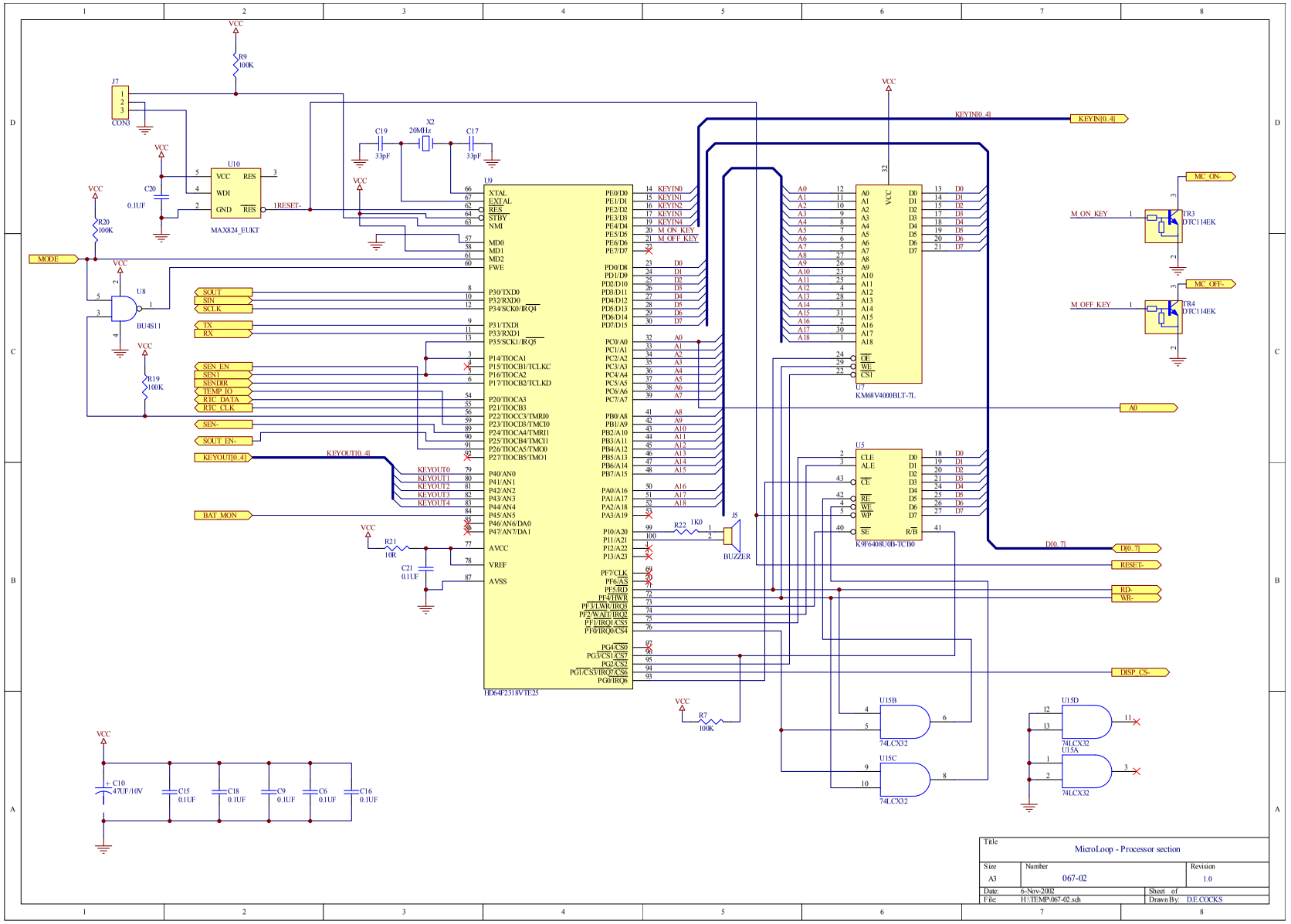
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MD0
MD1
MD2
FWE
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P32/RXD0
P34/SCK0/IRQ4
P31/TXD1
P33/RXD1
P35/SCK1/IRQ5
P14/TIOCA1
P15/TIOCB1/TCLKC
P16/TIOCA2
P17/TIOCB2/TCLKD
P20/TIOCA3
P21/TIOCB3
P22/TIOCC3/TMRI0
P23/TIOCD3/TMCI0
P24/TIOCA4/TMRI1
P25/TIOCB4/TMCI1
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P42/AN2
P43/AN3
P44/AN4
P45/AN5
P46/AN6/DA0
P47/AN7/DA1
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PE1/D1
PE2/D2
PE3/D3
PE4/D4
PE5/D5
PE6/D6
PE7/D7
PD0/D8
PD1/D9
PD2/D10
PD3/D11
PD4/D12
PD5/D13
PD6/D14
PD7/D15
PC0/A0
PC1/A1
PC2/A2
PC3/A3
PC4/A4
PC5/A5
PC6/A6
PC7/A7
PB0/A8
PB1/A9
PB2/A10
PB3/A11
PB4/A12
PB5/A13
PB6/A14
PB7/A15
PA0/A16
PA1/A17
PA2/A18
PA3/A19
P10/A20
P11/A21
P12/A22
P13/A23
PF7/CLK
PF6/AS
PF5/RD
PF4/HWR
PF3/LWR/IRQ3
PF2/WAIT/IRQ2
PF1/IRQ1/CS5
PF0/IRQ0/CS4
PG4/CS0
PG3/CS1/CS7
PG2/CS2
PG1/CS3/IRQ7/CS6
PG0/IRQ6
KEYIN0
KEYIN1
KEYIN2
KEYIN3
KEYIN4
M_ON_KEY
M_OFF_KEY
KEYIN[0..4]
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SIN
SCLK
TX
RX
SEN_EN
SEN1
SENDIR
TEMP_IO
RTC_DATA
RTC_CLK
SEN-
SOUT_EN-
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KEYOUT0
KEYOUT1
KEYOUT2
KEYOUT3
KEYOUT4
BAT_MON
R21
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C21
0.1UF
R22
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BUZZER
R7
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U15D
U15A
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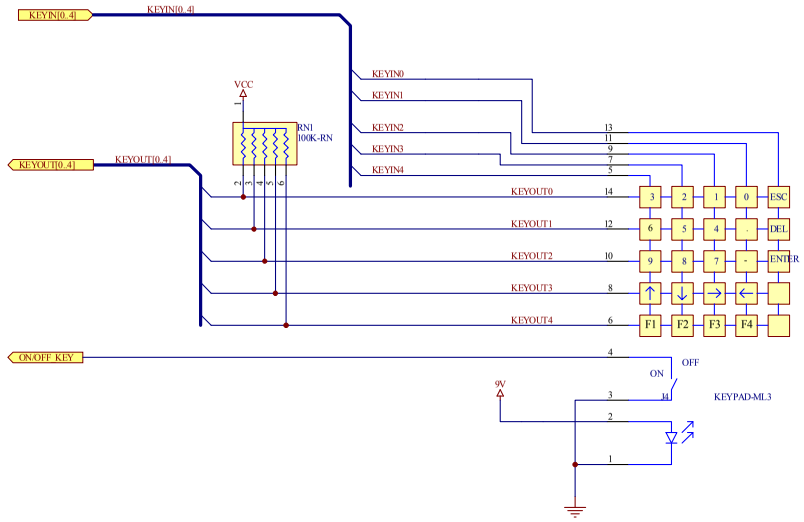

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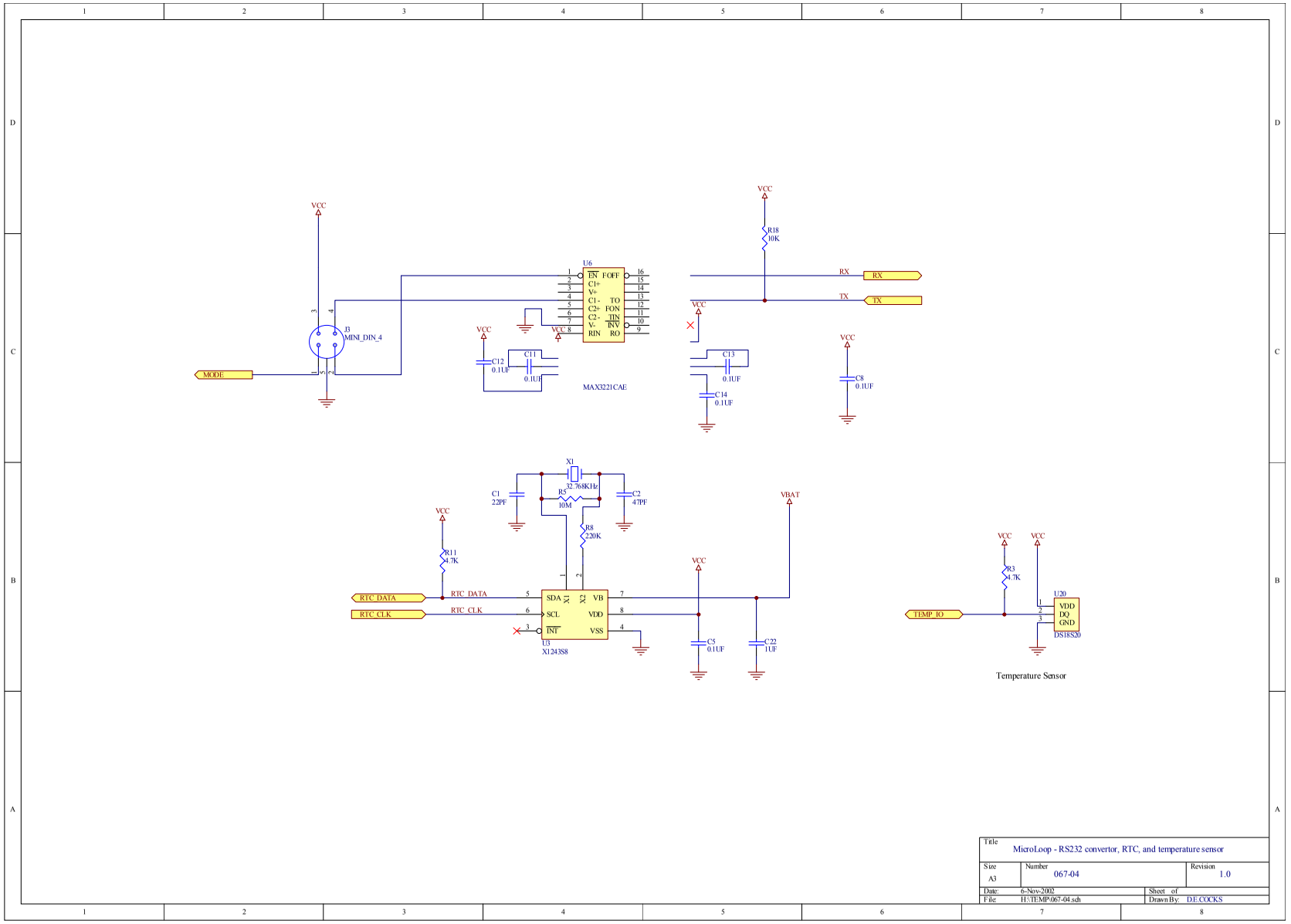
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C12
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C8
X1
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C1
22PF
C2
47PF
R5
10M
R8
220K
R11
4.7K
RTC_DATA
RTC_CLK
U3
X1243S8
VBAT
C5
C22
1UF
R3
TEMP_IO
U20
DS18S20
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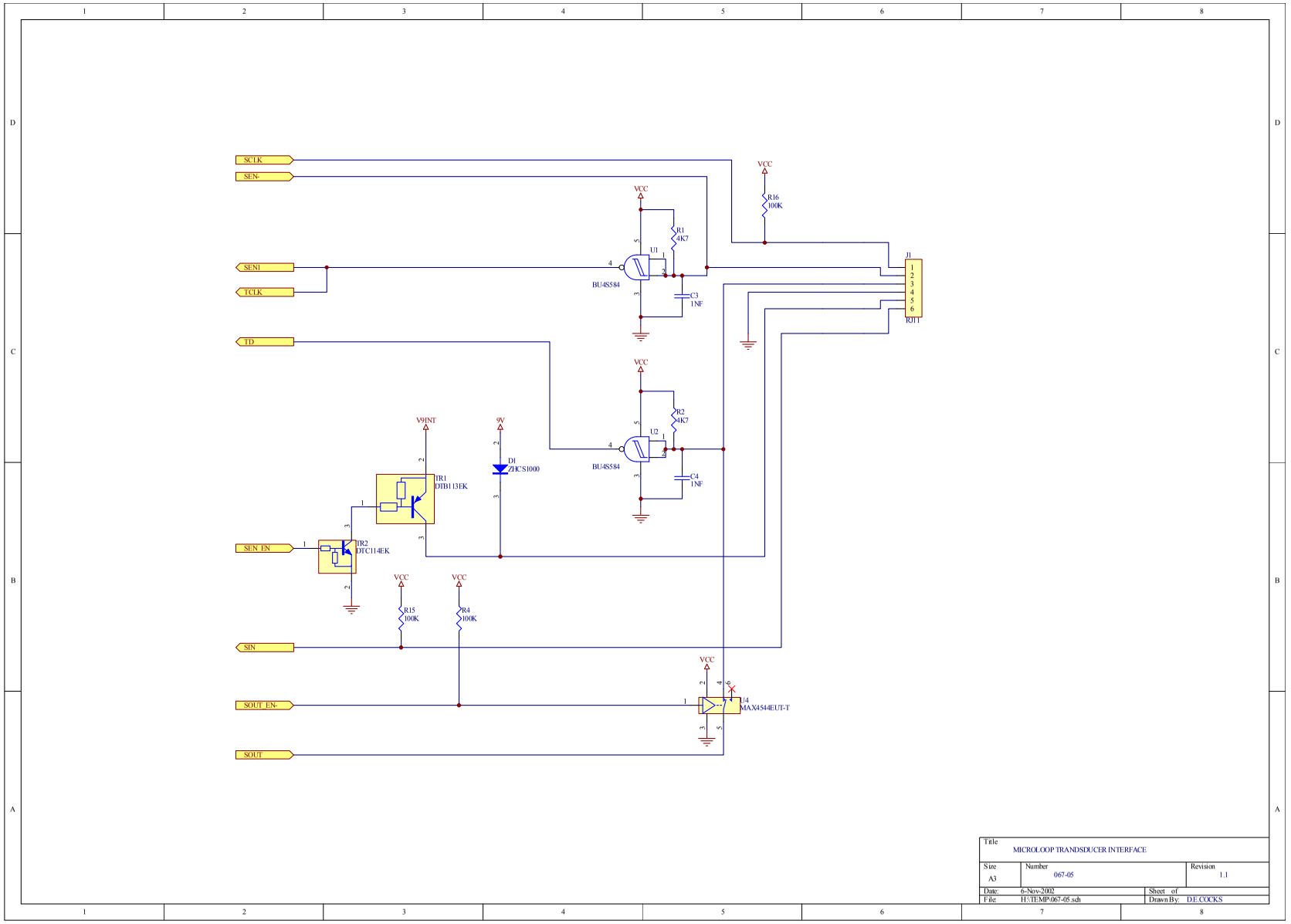
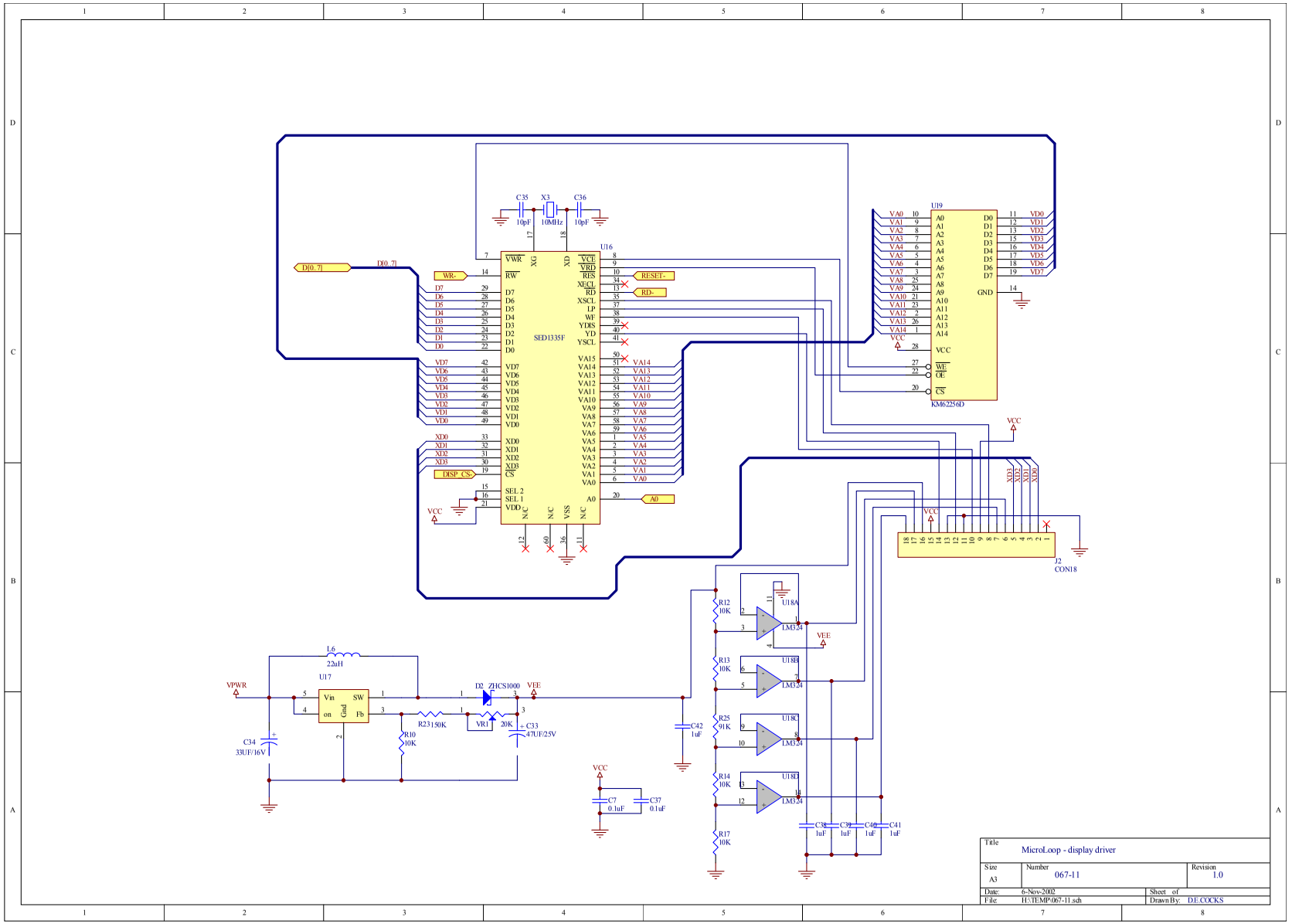
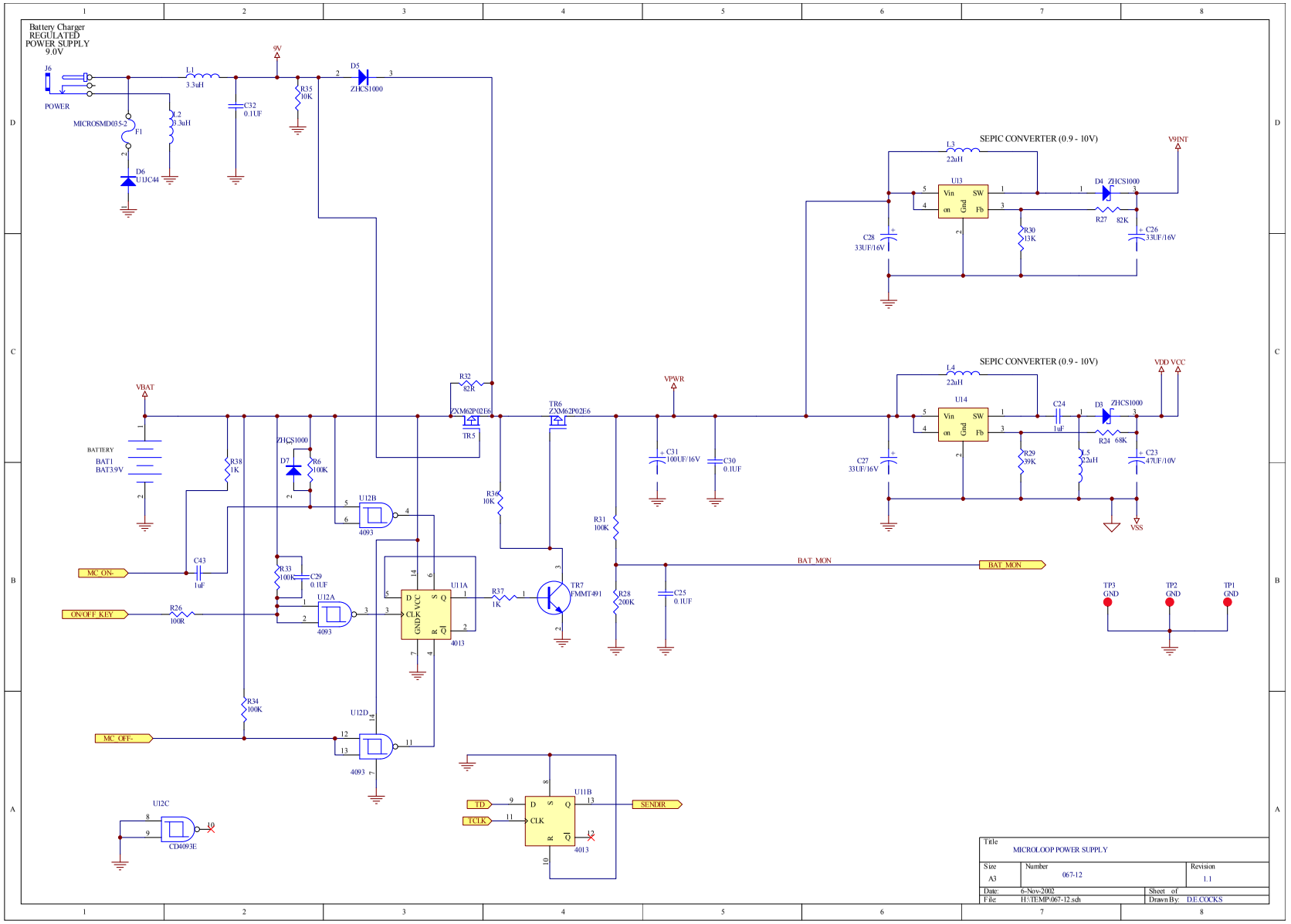
Drawn By:
D.E.COCKS


SCLK
SEN-
SEN1
TCLK
TD
SEN_EN
SIN
SOUT_EN-
SOUT
VCC
R16
100K
R1
4K7
U1
BU4S584
C3
1NF
J1
RJ11
R2
4K7
U2
C4
1NF
V9INT
9V
D1
ZHCS1000
TR1
DTB113EK
TR2
DTC114EK
R15
100K
R4
100K
U4
MAX4544EUT-T
Title
MICROLOOP TRANSDUCER INTERFACE
Size
A3
Number
067-05
Revision
1.1
Date:
6-Nov-2002
Sheet of
File
H:\TEMP\067-05.sch
Drawn By:
D.E.COCKS


U16
SED1335F
U19
KM62256D
J2
CON18
U17
U18A
U18B
U18C
U18D
LM324
D2 ZHCS1000
VR1 20K
R23 50K
R10 10K
C34 33UF/16V
C33 47UF/25V
C42 1uF
C7 0.1uF
C37 0.1uF
C35 10pF
X3 10MHz
C36 10pF
L6 22uH
VPWR
VCC
VEE
D[0..7]
WR-
RD-
RESET-
DISP_CS
A0
Title
MicroLoop - display driver
Size
A3
Number
067-11
Revision
1.0
Date:
6-Nov-2002
Sheet of
File
H:\TEMP\067-11.sch
Drawn By:
D.E.COCKS


Battery Charger
REGULATED
POWER SUPPLY
9.0V
SEPIC CONVERTER (0.9 - 10V)
SEPIC CONVERTER (0.9 - 10V)
MICROLOOP POWER SUPPLY
Size
A3
Number
067-12
Revision
1.1
Date:
6-Nov-2002
Sheet of
File
H:\TEMP\067-12.sch
Drawn By:
D.E.COCKS