SBC-386EX

Technical Manual

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Contents

Revision History

Issue	PCB	Comments
A	V1 Iss3	000804 Initial revision

Preface

Scope of this Manual

This manual details the operation and use of the SBC-386EX board. It has been designed as both a reference and a user manual and includes information on using all aspects of the board.

Name Conventions

Throughout this document a forward slash '/' prefix denotes that a signal is active low (e.g. /READ). All numbers are in decimal unless otherwise indicated. Where a number is suffixed by 'H' the value is in hexadecimal format.

Contents-Packing list

You should have this manual as part of the SBC-386EX development kit. In your development kit you should have:

- An SBC-386EX-S
- A document titled 'SBC-386EX Quickstart Manual'
- A mains voltage to +12V DC power supply complete with 3 plugs to allow use world-wide
- A crossover ethernet cable
- An 'SVIF1' PCB module
- An 'SVIF' cable (10-way IDC to two 9-way D-type male connectors)
- A CD-ROM titled 'SBC-386EX Development Kit CD-ROM', containing this document. Further details
- are given below

CD-ROM

The SBC-386EX Development Kit CD-ROM contains the following:

- Auto-installation program (setup.exe)
- SBC-386EX software libraries and help files
- Electronic copies of this manual and the SBC-386EX Quickstart Manual
- Electronic copy of the 'Intel 386EX Embedded Microprocessor User Manual'
- Datasheets (in PDF format) of the main devices used on the SBC-386EX
- Backup binary images of the default FLASH program pre-installed
- US Software's SuperTask! And Treck Real-Time TCP/IP manuals

The development kit Quickstart manual gives full details on the installation of software contained on this CD-ROM.

Anti-Static Handling

This board contains CMOS devices that could be damaged in the event of static electricity being discharged through them. At all times, please observe anti-static precautions when handling the board and always unpack and install it in an anti-static working area.

Electromagnetic Compatibility (EMC)

The board has been tested in an unscreened plastic enclosure and complies with the following EMC standards:

Radiated Emissions:	AS/NZS 3548:1995 and EN 55022:1994 Class A	
Electrostatic Discharge Immunity:	IEC 1000-4-2:1995	(EN 61000-4-2)
Radiated RF Immunity:	IEC 1000-4-3:1995	(EN 61000-4-3)
Fast Burst Transient Immunity:	IEC 1000-4-4:1995	(EN 61000-4-4)

The SBC-386EX is classified as a component with regard to the European Community EMC regulations and it is the user's responsibility to ensure that systems using the board are compliant with the appropriate EMC standards.

Packaging

Please ensure that should a board need to be returned to Arcom, it is adequately packed. Use an anti-static bag for the board and use a box, not bag, to physically protect the board. An anti-static bag is not required if the board is being returned in the original development kit box, which has an anti-static foam interior.

Introduction

The SBC-386EX is a single board computer with networking capabilities. The board is based on the Intel 80386EX embedded processor and has 2MBytes of DRAM and 1MBytes of FLASH memory as standard. There are two variants of the board:

SBC-386EX-S	Single board computer with 2MB DRAM, 1MB FLASH, 512KBytes of SRAM
SBC-386EX	Single board computer with 2MB DRAM, 1MB FLASH, no SRAM

The 512KByte SRAM on the SBC-386EX-S variant is battery backed, as is the Real Time Clock present on both variants. There are several possible memory-mapping modes, selectable by surface mount links. The default configuration and the additional modes are detailed later in this manual.

Features

- Intel 386EX 25MHz processor
- 2Mb DRAM
- 1Mb Flash, configurations of 128Kb x8 pages or linear access
- 512Kb SRAM battery backed, 16Kb x 32 pages or linear access
- 10-BaseT ethernet port with link status LED
- COM1 and COM2 RS422 serial ports via 20-way pin header
- COM3 configured for 4-wire RS485 (non-isolated) comms via 9-way DSUB (female)
- Real Time Clock, battery backed
- Software watchdog with configurable timeout period
- Transmit and receive activity LED's for COM1 and COM2
- User LED on board
- User-assigned jumper link
- Debug port for software development
- 8-18V DC and 10-16V AC power input ranges
- Power consumption, typical 280mA @ 12V DC
- Operating temperature range, -20ºC - +75ºC
- MTBF 163,500 hours; calculated using generic figures from MIL-HDBK-217F at ground benign

Getting Started

The SBC-386EX and this manual are supplied as part of a development kit, which includes everything that is required to start developing and running code on the board. To get started using the board, read the printed manual contained in the development kit "SBC-386EX Quickstart manual".

Chip Selects and Interrupts

The chip selects and interrupts external to the 386EX are routed as shown below. Internal 386EX mapping is determined by software. A full default configuration IO settings table, interrupt assignment table and port pin connections table are given in Appendix B.

Chip Select	Interrupt pin	Selects / Interrupt from
UCS	-	FLASH memory
CS0	-	DRAM memory
CS1	-	FLASH/SRAM page register
CS2	-	SRAM memory
CS3	INT1	Ethernet
CS4	INT2	SVIF and IO port (IO port not fitted)
CS5	INT0	COM3
CS6	-	Used for DRAM refresh

Memory Map

There are three areas of memory on the SBC-386EX:

- 2MBytes of DRAM
- 1MByte of FLASH
- 512KBytes of battery-backed SRAM (optional).

The FLASH memory area is located at the top of the 386EX-memory map and contains the restart vector executable code and the Arcom MiniMonitor application. The default memory configuration for the SBC-386EX utilising Arcom's Flash Filing System (AFFS) is for a 1Mbyte memory space to be visible and mapped as shown in the diagram below (figure 1). The AFFS allows the unused memory areas in the FLASH device to be treated as a conventional application filing system.

When running 16-bit applications, the logical memory map cannot exceed 1MByte. For the full 2MB of DRAM to be visible to the 386EX processor, "flat" 32-bit mode (protected mode) must be used. Maximum flexibility can be achieved with this mode by simply presenting the entire memory map to the application. In this mode of operation the application code and memory drivers do not need to consider memory page selection. All DRAM, FLASH and SRAM appear at their respective linear address. However, to use this mode the surface mount links need to be changed as follows:

FLASH MEMORY:

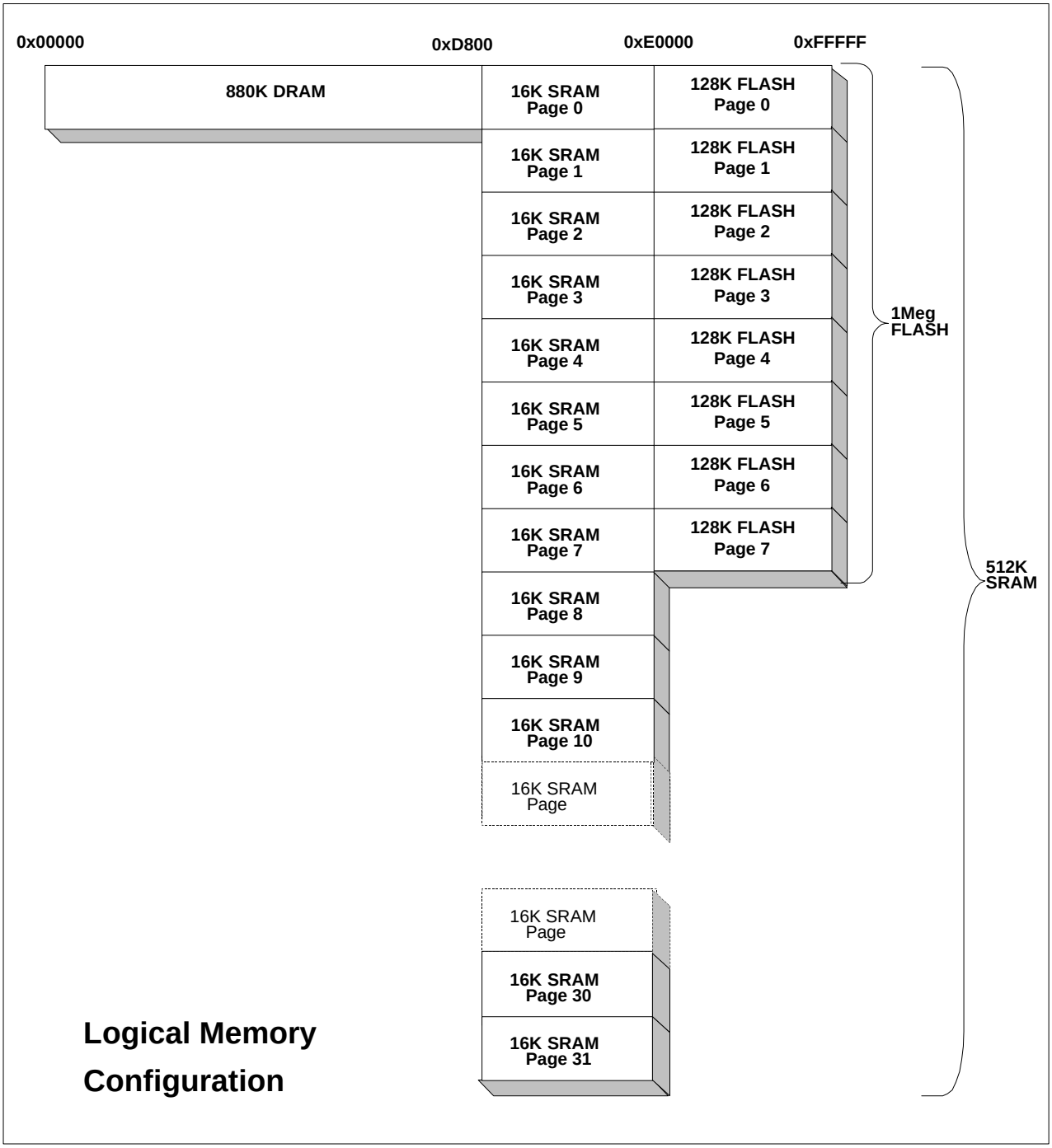
Page select		Flat model	
Page0	fit R81	A17	fit R75
Page1	fit R80	A18	fit R74
Page2	fit R79	A19	fit R73

Thus either R81 (page0) or R75 (A17) should be fitted (with a 0R 0603 resistor): never both positions or neither position. The same is true of R80 (page1) and R74 (A18) and likewise R79 (page2) and R73 (A19). A number of different memory mapping/paging options are thus possible (e.g. fitting A17, A18 and Page2 to give 2 x 512Kbyte pages of FLASH), but generally only the default 16-bit mapping shown in Figure 1 and the 32-bit flat model are used.

The flat 32-bit mode memory map for the SBC-386EX is shown in figure 2.

SRAM MEMORY:

Page select		Flat model	
Page0	fit R78	A17	fit R72
Page1	fit R77	A18	fit R71
Page2	fit R126	A19	fit R127
Page3	fit R128	A18	fit R129
Page4	fit R130	A19	fit R131



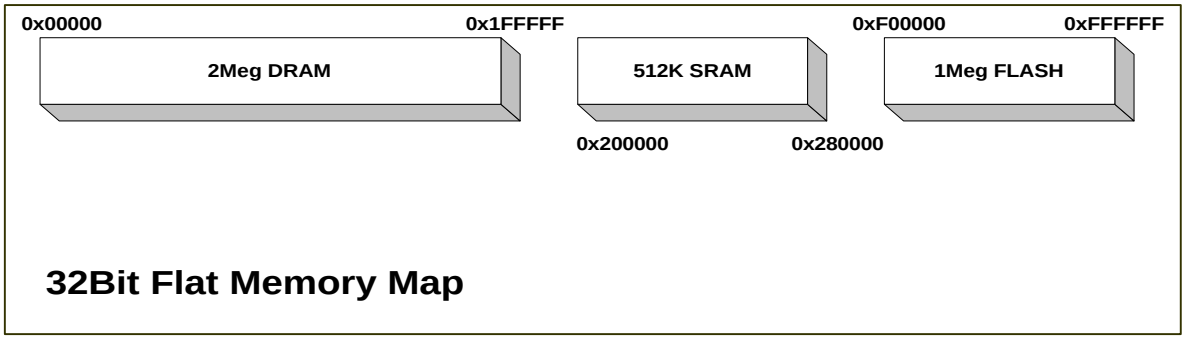


Figure 2 - Flat 32-bit Memory Map for the SBC-386EX

Links

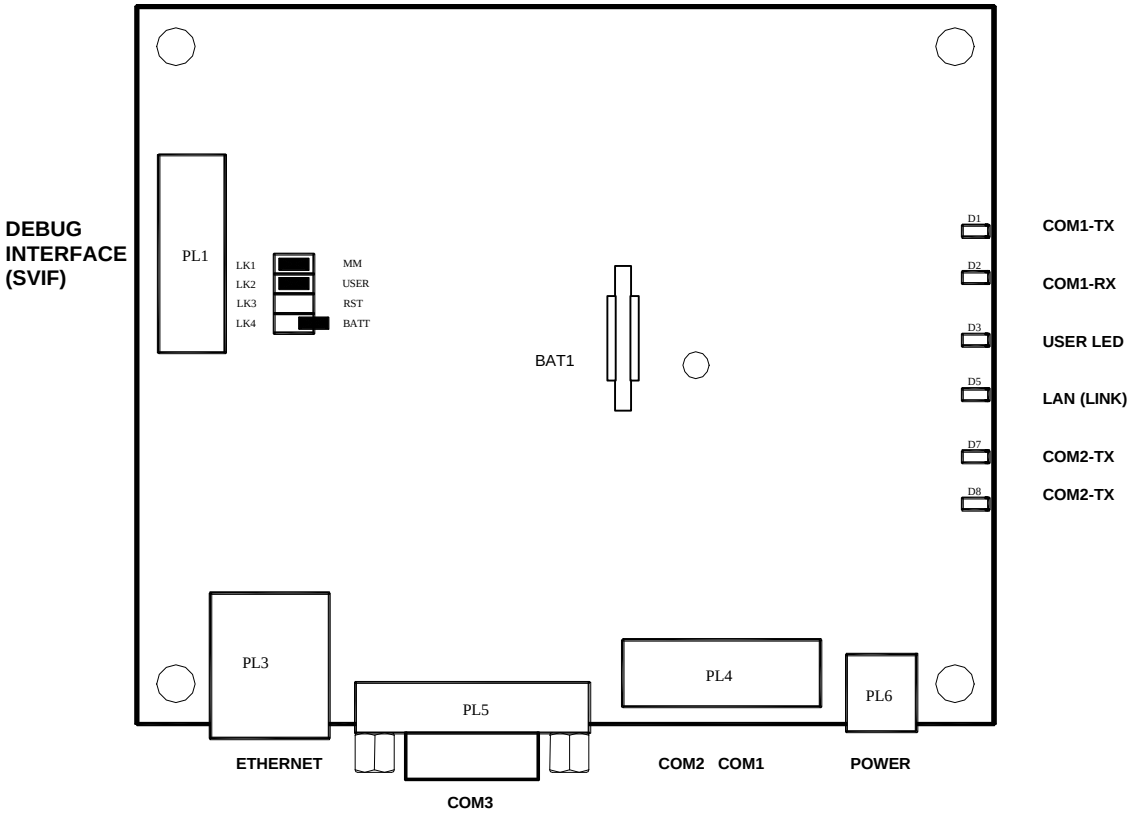
Link1 - MiniMonitor (default is fitted)
Fit to boot up into MiniMonitor debug environment. When not fitted, code jumps to application start vector.

Link2 - User assigned link (default is fitted)
Link2 is user assigned. When not fitted, P1.7 is pulled high, when fitted, P1.7 is pulled low.

Link3 - Reset header (default is not fitted)
When the pins of link3 are shorted for greater than 40ms, the SBC-386EX is reset.

Link4 - Battery Connect (default is not fitted)
When fitted, the battery is connected to the battery-backup circuit of the SBC-386EX. When not fitted, the battery is open circuit.

Top view link settings (factory default)



On-board Functions

COM1 and COM2

COM1 and COM2 are 4-wire full-duplex RS-422 serial communications ports. They are directly supported by the 386EX processor and have 16450 compatibility. As standard these ports support interrupt driven communications through the normal IRQ3 and IRQ4. The maximum baud rate supported is 115.2Kbaud.

In addition to the RS-422 comms signals TX(+/-) and RX(+/-), COM1 and COM2 provide two differential handshaking signals, /RTS(+/-) and /CTS(+/-). Full signal pin-out is shown in Appendix A.

COM1 and COM2 are available on the 20-way 0.1" header PL4. See Appendix A for pin-out details.

COM3

COM3 is a 4-wire full-duplex RS-485 serial communications port. It is supported by a 16550 compatible UART. The RS-485 transmitter is enabled with the UART /RTS signal. By connecting TX+ to RX+ and TX- to RX- (externally to the SBC-386EX board), COM3 can be used as a half-duplex 2-wire RS-485 port. In this configuration, transmission is still enabled by /RTS, but the receiver is always enabled and thus transmitted data is automatically received on the COM3.

The UART has a 16 byte receive buffer, but interrupt driven communications is supported via the INT0 pin of the 386EX, which is connected to IRQ1 in the default software configuration of the SBC-386EX. The maximum baud rate supported is 115.2Kbaud. COM3 RS-485 signals are non-isolated.

In addition to the RS-485 comms signals TX(+/-) and RX(+/-), COM3 provides two differential handshaking signals, /DTR(+/-) and /DCD(+/-). The UART general purpose output signal, /OP1, is used to control the transmit enable of /DTR in the same manner as /RTS is used to control TX. COM3 is brought out via the 9-way D-type socket, PL5. Full signal pin-out is shown in Appendix A.

Ethernet Port

The SBC-386EX has a 10BaseT Ethernet port via an RJ45 connector (PL3). The Ethernet port is supported by a Realtek RTL8019AS device connected to the 386EX in 8-bit mode. A serial EEPROM is used to store the network settings including the port's MAC ID.

A link status LED (D5) indicates the presence of a physical Ethernet connection to PL3. The SBC-386EX FLASH is pre-loaded with a real time Treck TCP/IP stack to support communication on this port.

Real Time Clock

A Dallas DS1302 device is used for the Real Time Clock (RTC). This device is interfaced via 386EX port pins P1.2 (SCLK), P1.3 (/RST) and P1.4 (I/O). This device has a dedicated 32.768KHz crystal and is powered through the SBC-386EX battery backup circuit. The crystal has an accuracy of ±2 seconds per day (at 25ºC). The RTC includes 31 bytes of battery backed RAM.

Software Watchdog

The 386EX processor has internal watchdog circuitry, which is software controlled. This can be used to reset the SBC-386EX. If the software watchdog times-out, a reset pulse is generated. This reset pulse is fed back on-board the SBC-386EX to hardware reset the 386EX processor and the COM3 UART.

The watchdog timeout period is software selectable. See the 'Intel 386EX Embedded Microprocessor User's

Battery

A CR2032 (or equivalent) lithium battery is used to support the Real Time Clock and SRAM memory while main board power is disconnected. The battery has a capacity of 230mAh. It is not re-chargeable. The board is shipped with the battery link (LK4) not connected in order to preserve battery life while the board is not in use. The battery life is dependent on both the board variant and on the ambient temperature of the board. At a constant 25ºC ambient temperature the battery life will typically be:

SBC-386EX-S	3 years
SBC-386EX	7 years

Actual battery life is dependent on:

- the total life of the battery (it will decay over time even when open circuit)
- the variance in current drawn by the SRAM and RTC devices due to batch differences
- temperature

The figures given above are for guidance only and are not a guarantee.

Unique Electronic ID

As Dallas DS2401 'Silicon Serial Number' IC is connected to port pin P3.5 of the 386EX. Each device has a unique 48-bit serial number pre-programmed into the device. This allows each SBC-386EX board to be uniquely identified. A software driver for reading this device is supplied with the SBC-386EX development kit software libraries.

Power Supply

Power Input Circuit

The SBC-386EX is capable of being power from either a DC or an AC power supply. AC supplies are full-wave rectified on-board. The resulting DC voltage is then regulated to +5.0V. All logic devices on the SBC-386EX are +5V only. The power input requirements are:

DC Input:	+8V to +18V
AC Input:	+10V to +16V rms

The power rating of the board is approximately 4W. The SBC-386EX power input circuit includes a 750mA resettable fuse to protect the board (and power supply) in the event of a short circuit. A transient suppressor protects the board from high voltage transients from the power supply. The Micrel MIC4680 regulator also provides over-current protection and thermal shutdown circuitry.

The Intel 386EX can be put into a power saving 'IDLE' mode to save on power. If put into IDLE mode the SBC-386EX power requirements are reduced by approximately 1W, giving a resulting power input requirement of 3W. See the 'Intel 386EX Embedded Microprocessor User Manual' (included on the Development Kit CD-ROM) for further details regarding power saving modes of the 386EX.

The DC jack socket on the SBC-386EX has a 1.6mm diameter pin, and has a 5.2mm diameter hole. It is ideally suited for bayonet locking style DC jack connectors.

Development Kit Power Supply

A 15W, +12V DC power supply is included in the development kit. This power supply can be used in most countries and is rated to take a mains input of between 100V and 240V, at 47 - 63Hz. The power supply comes with three plugs (included in the kit) which allow it to be used in a variety of countries. The correct plug for your country should be selected and plugged into the main body of the supply.

The power supply comes complete with 1.5m of figure-8 cable and a 1.6mm DC jack which mates with the power connector (PL6) of the SBC-386EX.

Software Development

Introduction

The SBC-386EX has a development debug port, PL1, which allows the user to download, run and debug software. An Arcom SVIF1 header and cable (supplied with the development kit) is required to interface with this port and to connect to a host PC's serial port. By inserting the link in LK1 before power-up, the SBC-386EX will run its monitor program (MiniMonitor), which allows a user direct control of the 386EX processor's memory and IO operations. By the use of a suitable software debug tool such as 'Paradigm Debug', programs can be loaded onto the SBC-386EX and then analyzed and debugged via the 'SVIF' port. Paradigm Debug is the preferred software tool for debugging software on the SBC-386EX and the Paradigm Remote kernel, which is the portion of Paradigm required to run on the target board, is included on the development kit CD-ROM.

The SBC-386EX is supplied with a working SuperTask operating system from US Software, complete with a Treck TCP/IP stack and a FLASH filing system. Upon power-up with no link fitted to LK1, the board will boot-up with the default IP address of 10.1.100.1. If connected to a PC which has its domain set so that it can communicate with a device at this address, file transfers, directory listings and other file/directory functions can be performed using FTP on the host PC.

SVIF Development Interface

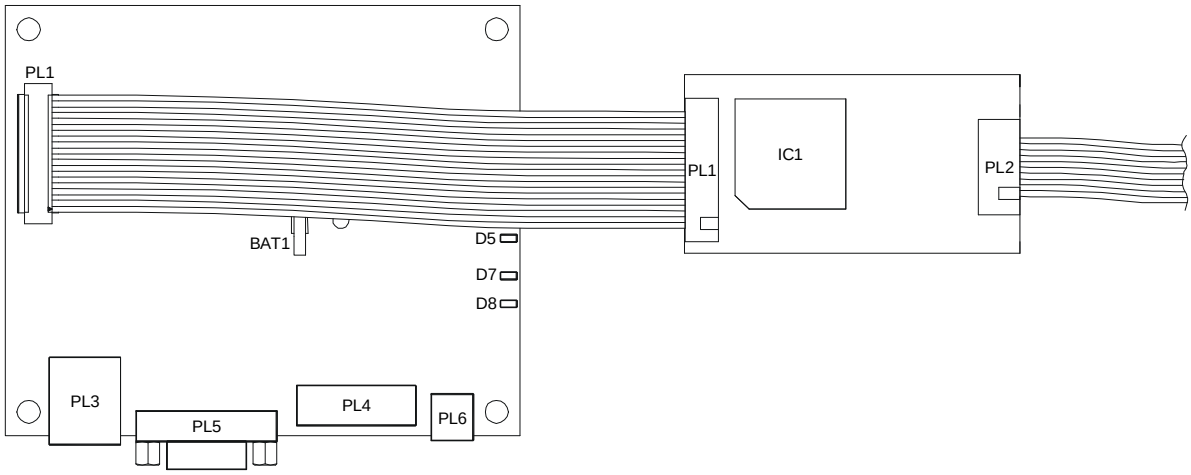


Figure 3. Connecting to the SVIF Debug Interface

Before connecting the SVIF1 module onto the SBC-386EX ensure that link LK1 is inserted. The SVIF1 module 20-way ribbon cable header connects into PL1 of the SBC-386EX in the orientation shown in figure 3.

Plug the SVIF cable 10-way header into PL2 of the SVIF1 module and connect PLUG B of the cable into COM1 or COM2 of the host PC. Open up a HyperTerminal session on your host PC. Set the terminal emulator to use the COM port the you have connected PLUG B to, and set the port setting as follows:

Baud Rate: 19200
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

Plug the power supply into the SBC-386EX. You should now see something like this in your terminal emulator window:

```
--==<< SBC-386EX TARGET MINI-MONITOR >>==--
              Version 1.01d (SVIF)
Copyright (C) Arcom Control Systems 2000

Application jump vectors: 7440:24EC

0100>
```

Type: H

You will see a list of available commands that can be used with the MiniMonitor. Further details of how to download files, and in particular, the Paradigm Remote hex file for using with Paradigm Debug software is given in Arcom's Paradigm/Borland C++ SDK (software development kit) CD. This SDK is not included in the development kit. Please contact Arcom Control Systems for further information.

Connecting via FTP

Connect the SBC-386EX direct to a PC's Ethernet port using a crossover ethernet cable (supplied in the development kit), or to PC via an ethernet hub using an ethernet patch cable (not supplied). It is suggested that you initially connect the SBC-386EX directly to a PC not connected to a network.

Ensure that link LK1 is not in place and then plug a suitable power supply into the SBC-386EX. See figure 4.

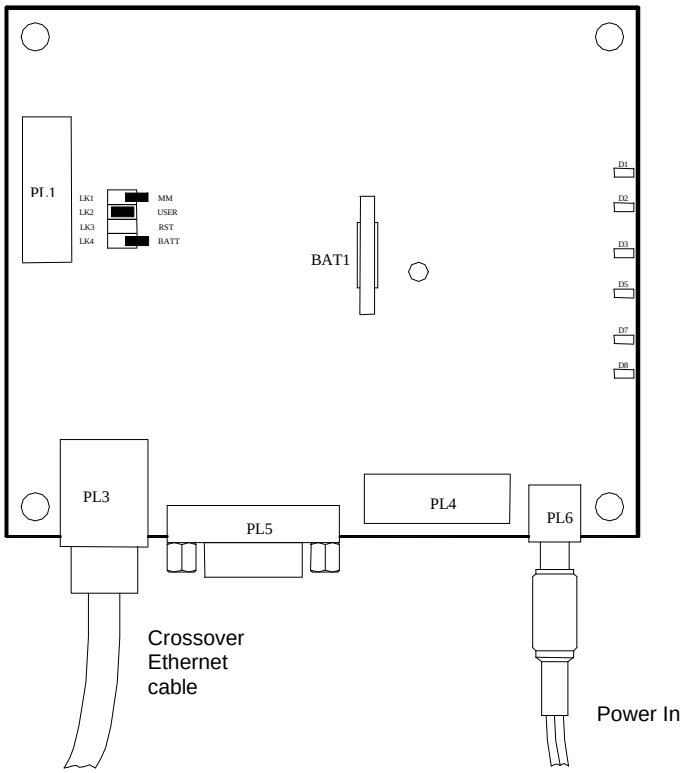


Figure 4. Connecting to Ethernet port of SBC-386EX

The SBC-386EX will boot up and after approximately 20 seconds, it can be connected to an FTP session on the host PC. An FTP server is run on the SBC-386EX as default. The PC must be configured so that it is in the same domain as the SBC-386EX, which has a default IP address of 10.1.100.1.

Most FTP client software can be used on the host PC to connect to the SBC-386EX FTP server. MS Windows comes with a DOS FTP utility. If WSFTP client is used, Chameleon must be selected as the “Host Type” to display the files correctly.

Appendix A - Connections

PL1 - SVIF (debug port)

20-way 0.1” header

PIN	SIGNAL	PIN	SIGNAL
1	GND	2	GND
3	/RD	4	/WR_SVIF
5	D0	6	D1
7	D2	8	D3
9	D4	10	D5
11	D6	12	D7
13	/BLE	14	A1
15	/CS_SVIF	16	/NMI
17	VCC	18	386EX CLKOUT
19	VCC	20	VCC

PL2 - JTAG/TAPFLASH

6-way 2mm pin header

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	TDO	2	TDI
3	TMS	4	TCK
5	VCC	6	GND

PL3 - Ethernet (10BaseT)

8-way RJ45

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	TX+	2	TX-
3	RX+	4	N/C
5	N/C	6	RX-
7	N/C	8	N/C

PL4 - COM1 and COM2 (RS-422 ports)

20 way 0.1” boxed header

PIN	SIGNAL	PIN	SIGNAL
1	N/C	2	TX(1)+
3	TX(1)-	4	RX(1)+
5	RX(1)-	6	/CTS(1)+
7	/CTS(1)-	8	/RTS(1)+
9	/RTS(1)-	10	[VCC_SRAM]
11	N/C	12	TX(2)+
13	TX(2)-	14	RX(2)+
15	RX(2)-	16	/CTS(2)+
17	/CTS(2)-	18	/RTS(2)+
19	/RTS(2)-	20	N/C

PL5 - COM3 (4-wire RS485 serial port)

9 way D-type female

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	N/C	2	TX(3)-
3	RX(3)-	4	/DCD(3)-
5	/DTR(3)-	6	TX(3)+
7	RX(3)+	8	/DCD(3)+
9	/DTR(3)+		

PL6 - Power connector

DC jack power connector.

PIN	DC POWER	AC POWER
Inner	9-18V DC	10-16V AC rms (live)
Outer	GND	10-16V AC rms (neutral)

Appendix B - IO Mapping

IO Address Table

Expanded Address	IO Function	Used
FC10 - FC1F	IO Expansion Port	No* (CS4)
FC0C - FC0F	SVIF Port	Yes (CS4)
E4E8 - E4EF	COM3	Yes (CS5)
0400	Flash/SRAM Paging Register	Yes (CS1)
0300 - 031F	Ethernet Port	Yes (CS3)
F8F8 - F8FF	COM2 (386EX UART 1)	Yes
F860 - F874	386EX Parallel Ports	No
F820 - F836	Device Configuration	Yes
F800 - F804	Power Management	Yes**
F4F8 - F4FF	COM1 (386EX UART 0)	Yes
F4C0 - F4CA	386EX Watchdog	Yes
F4A0 - F4A7	Refresh Controller	Yes
F480 - F48A	Synchronous Serial Port	No
F400 - F43F	Chip Select Unit (CSU)	Yes
F0A0 - F0A1	Slave INT Controller	Yes
F092	PORT92	Not rec'md
F080 - F09B	DMA Page	No
F040 - F043	Timer/Counter	No
F020 - F021	Master INT Controller	Yes
F000 - F01E	DMA/BUS-ARB	No
0022	REMAPCFG	Yes

Shaded part of table indicates functions internal to the 386EX processor.
* The IO expansion port pins have not been fitted to the SBC-386EX or SBC-386EX-S standard variant boards.
** Switching the 386EX processor into IDLE mode will save approximately 1W power consumption.

IRQ Interrupt Mappings

ICU IRQ	Function
IRQ0	Internal Timer/Counter 0
IRQ1	COM3 (via INT0 pin)
IRQ2	Interrupt Cascade to Slave ICU
IRQ3	COM2 (SIO INT1)
IRQ4	COM1 (SIO INT0)
IRQ5	Ethernet (via INT1 pin)
IRQ6	Reserved for IO Expansion Port
IRQ7	-
IRQ8	-
IRQ9	-
IRQ10	Internal Timer/Counter 1
IRQ11	Internal Timer/Counter 2
IRQ12	-
IRQ13	-
IRQ14	-
IRQ15	Watchdog Timeout

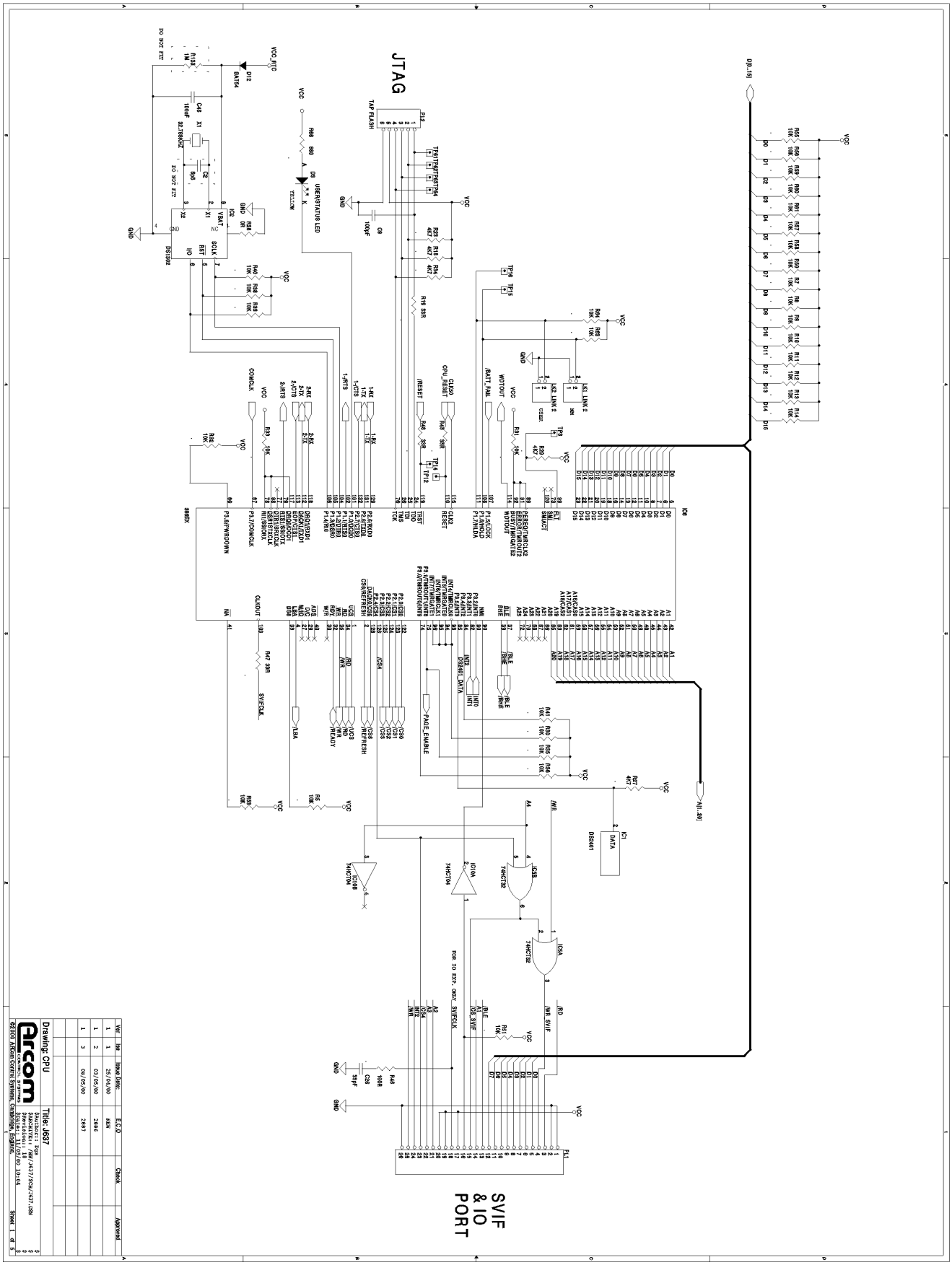
386EX Port Pin Assignments

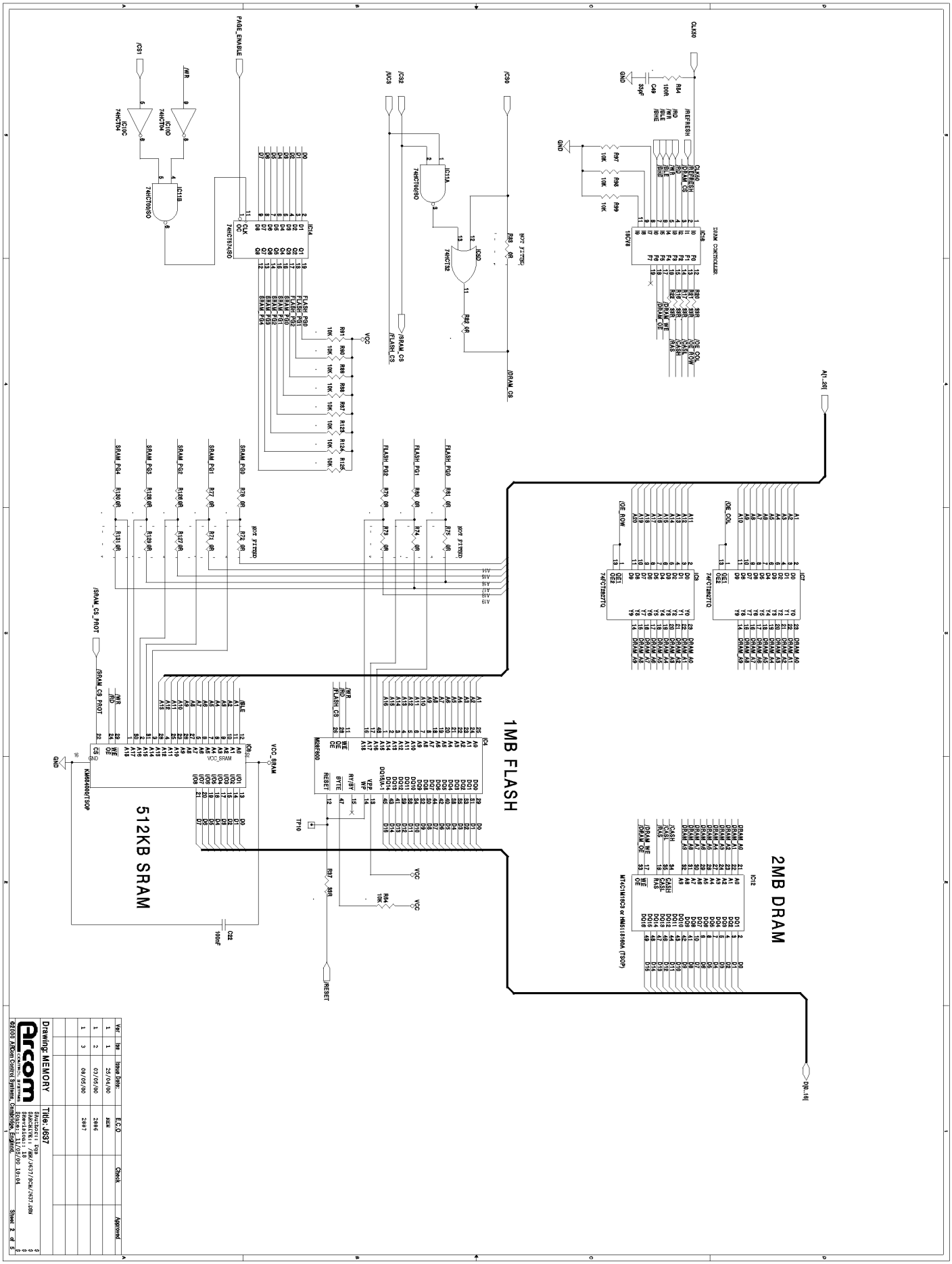
Port Pin	Function	Input / Output
P1.0	User / Status LED (low switches D3 on)	Output
P1.2	RTC SCLK	Output
P1.3	RTC /RST	Output
P1.4	RTC I/O	I/O
P1.5	Battery Fail (active low)	Input
P1.6	Link1 (low indicates link present)	Input
P1.7	Link2 (low indicates link present)	Input
P3.1	Memory paging register output enable (active low)	Output
P3.5	Silicon serial number (Dallas ID chip) data line	I/O
P3.7	Serial communications clock (1.843MHz)	Input

Memory Page Register (/CS1)

Data bit	Page bit
D0	FLASH Page0
D1	FLASH Page1
D2	FLASH Page2
D3	SRAM Page0
D4	SRAM Page1
D5	SRAM Page2
D6	SRAM Page3
D7	SRAM Page4

Appendix C - Circuit Diagrams




1MB FLASH
512KB SRAM
2MB DRAM
Drawing: MEMORY
Title: J637
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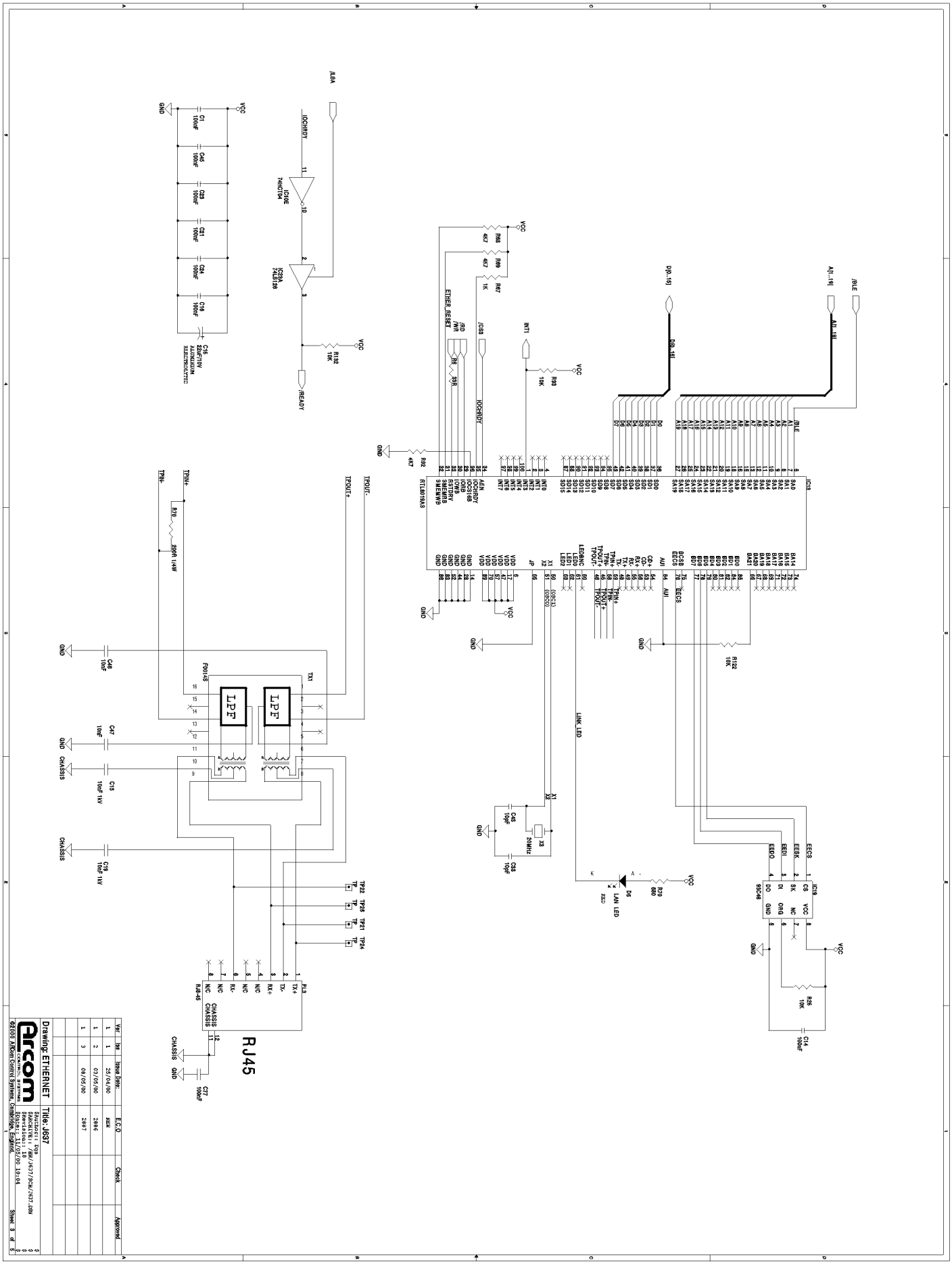
Sheet 2 of 5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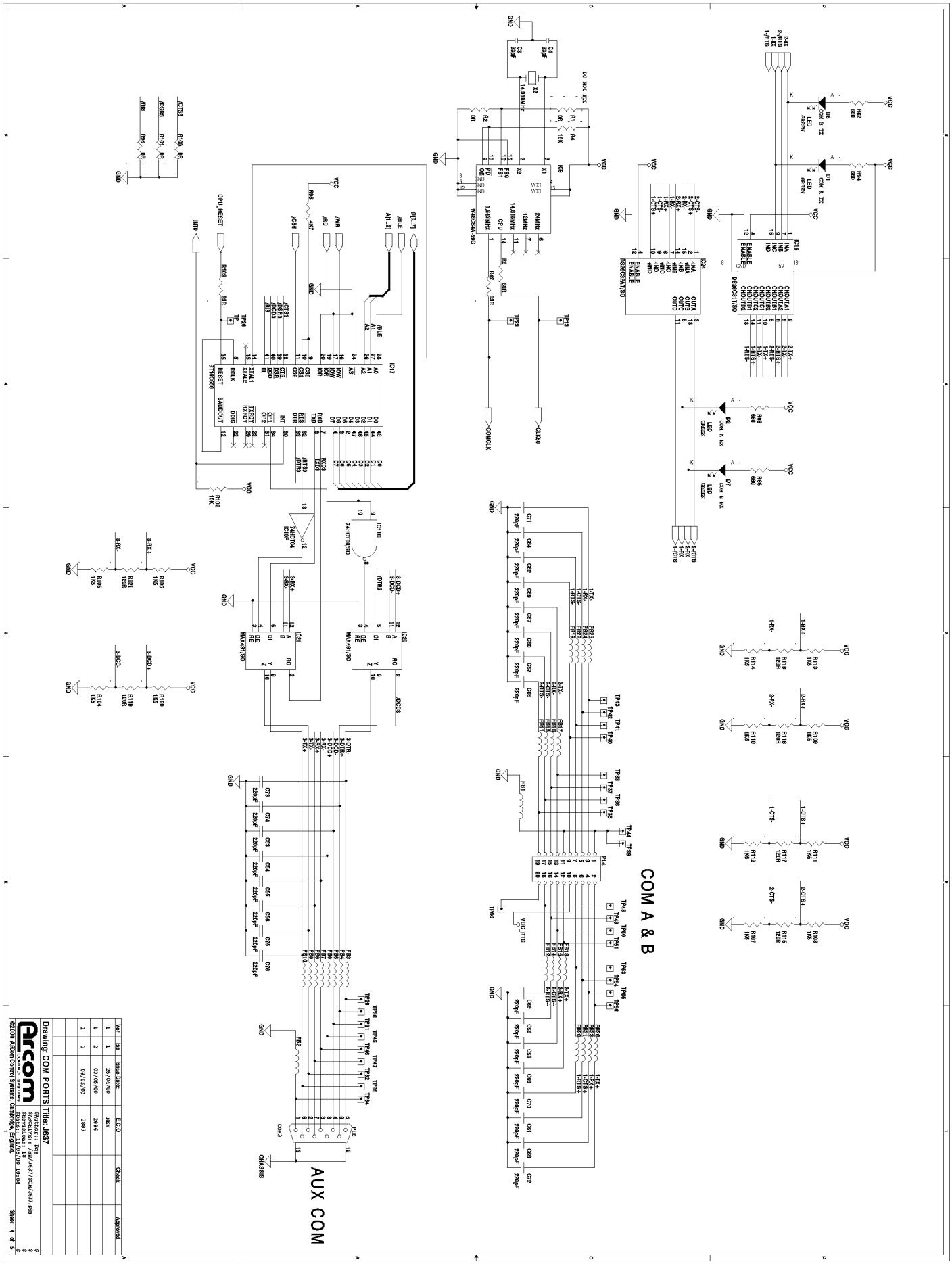
IOCS16A
74LS126
/READY
VCC
GND
/BLE
A[1..19]
D[0..15]
ETHER RESET
/CS8
INT1
IOCHRDY
RTL8019AS
LPF
TX1
RJ45
CHASSIS
LINK LED
LAN LED
93C46
TPOUT-
TPOUT+
TPIN-
TPIN+


COM A & B
AUX COM
Drawing: COM PORTS Title: J637
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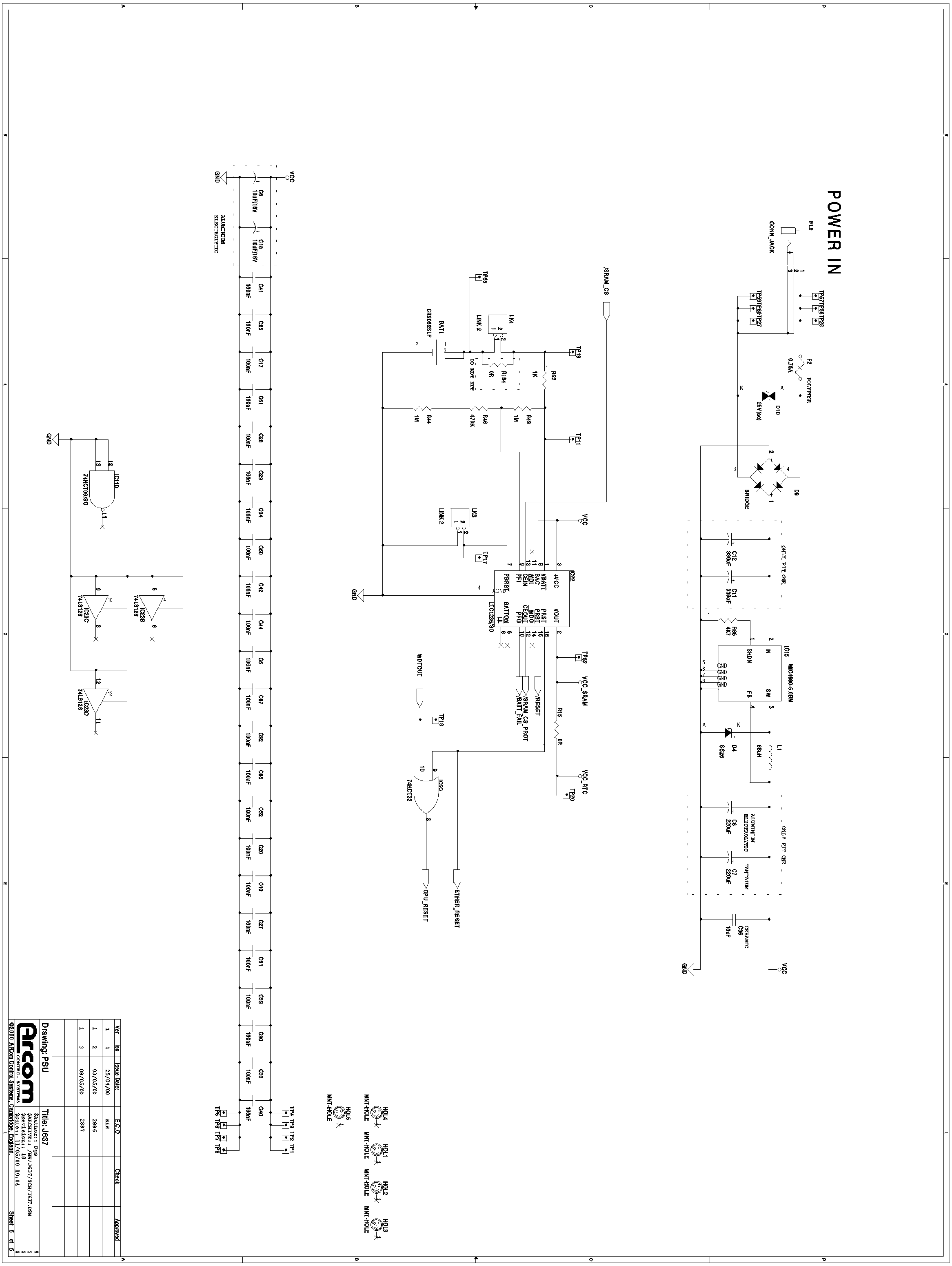
Sheet 4 of 5


POWER IN
Drawing: PSU
Title: J637