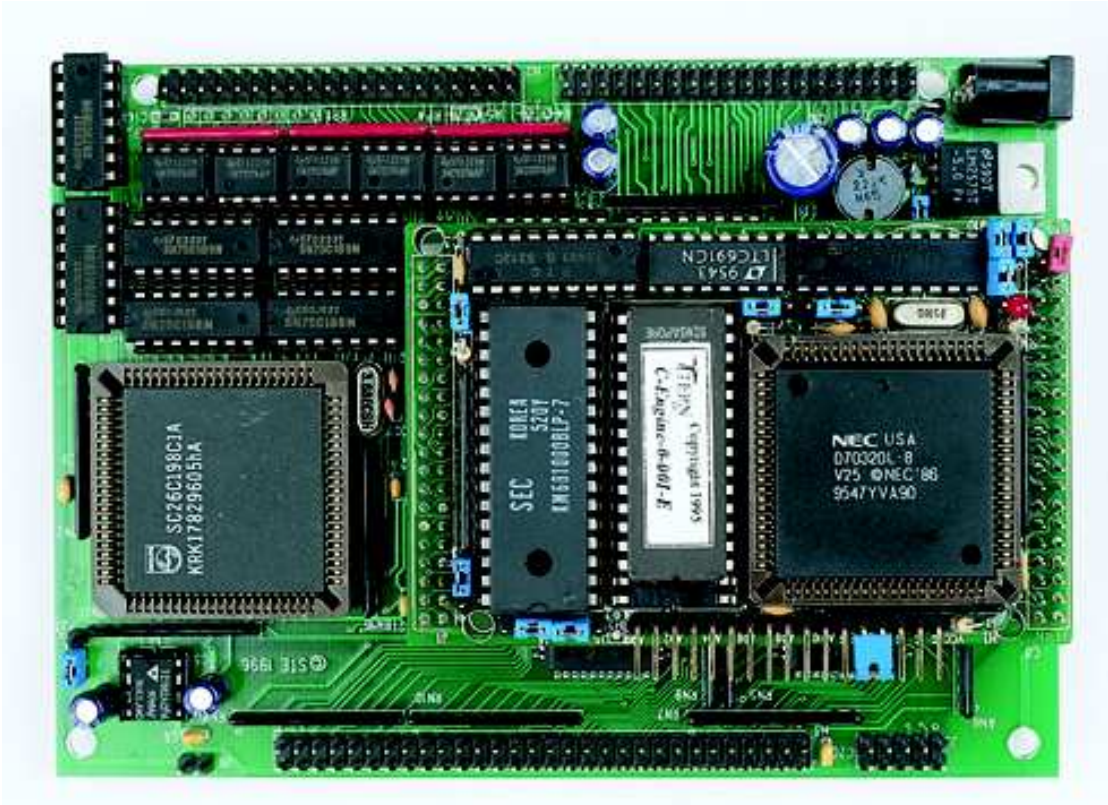
LittleDrive™

An embedded controller
with 10 UARTs, 22 solenoid drivers, and 80 I/O lines.

Technical Manual



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Chapter 1
Introduction

1. Functional Description

The ***LittleDrive™*** is a low-cost, high performance, C/C++ programmable industrial embedded controller. It supports 10 serial ports, 80 I/O lines including 22 high-voltage, high-current drivers and LCD interface. The LittleDrive™ can be used in computer networking, process control, protocol switching, ISDN front ends, remote data acquisition and control. It is a standalone communication system controller.

There are two high speed V25 internal UART and eight industrial standard full duplex UARTs from Philips Octal UART SC26C198. Each UART has significantly deeper 16-byte receiver FIFOs and 16-byte transmit FIFOs. Automatic flow control using Xon/Xoff defined by the user or hardware CTS/RTS handshaking. The operating speed of each receiver and transmitter can be selected from one of 22 fixed baud rates or two programmable non-standard rates. To minimize interrupt overhead, an interrupt arbitration system is included to report the context of the interrupting UART via direct access to a Current Interrupt Register. The Octal UART provides a power-down mode to reduce power consumption. The ***LittleDrive™*** has 10 channels of full-duplex RS-232 drivers supporting TxD/RxD and handshaking. Up to six half-duplex RS-485 drivers can be installed. You may configure the system to four RS-232 and six RS-485 channels. Two Programmable Peripheral Interface (82C55) chips provide 24x2 I/O lines which are programmable in three major modes of operation. The ***LittleDrive™***'s 14 solenoid drivers are capable of sinking 350 mA each at 50V and eight high voltage drivers are capable of sourcing or sinking 350 mA, at 50V each. You may install an optional switching power supply supporting up to 35V DC input without generating excessive heat.

LittleDrive™ can be driven by a V25-Engine™ (VE), or a C-Engine™ (CE), or an A-Engine™(AE). In order to generate all standard baud rates without a second crystal, the VE/CE must use a 14.7456 Mhz crystal. As a host microprocessor module, the VE/CE/AE provides 11 channels of 12-bit ADC, I/O lines, three timers, two counters, watchdog timer, real time clock, EEPROM, PCMCIA interface and more.

1.2 Features:

- 5.65x4.05 inches. Borland or Microsoft C/C++ programmable
- 80 I/O lines including 24x2 PPI I/O lines.
- Power consumption: <200 mA. Linear/switching regulator
- 10 RS-232 serial ports or 6 RS-485 serial ports
- Octal UART SC26C198, 16 byte receive and transmit FIFOs
- Flow control with Xon/Xoff or hardware handshaking. Flexible baud rate 50 to 500K
- 14 channels of solenoid driver sinking. 8 channels of solenoid driver sourcing outputs
- Interface for character or graphic LCDs
- Driven by a C-Engine™ or a V25-Engine™, 16-bit CPU (V25), 8 Mhz clock
- EPROM/Flash (up to 512K) and SRAM (up to 512K)

- Battery backup for memory and real-time clock, watchdog and power-fail protection
- 11 channels of 12-bit ADC with C-Engine™
- V25 24 I/O lines, 3 external interrupts, 8 comparators. 3 timers, two counters (500KHz)
- Serial EEPROM 512 bytes (up to 2K). Real-time clock RTC72421, lithium coin battery

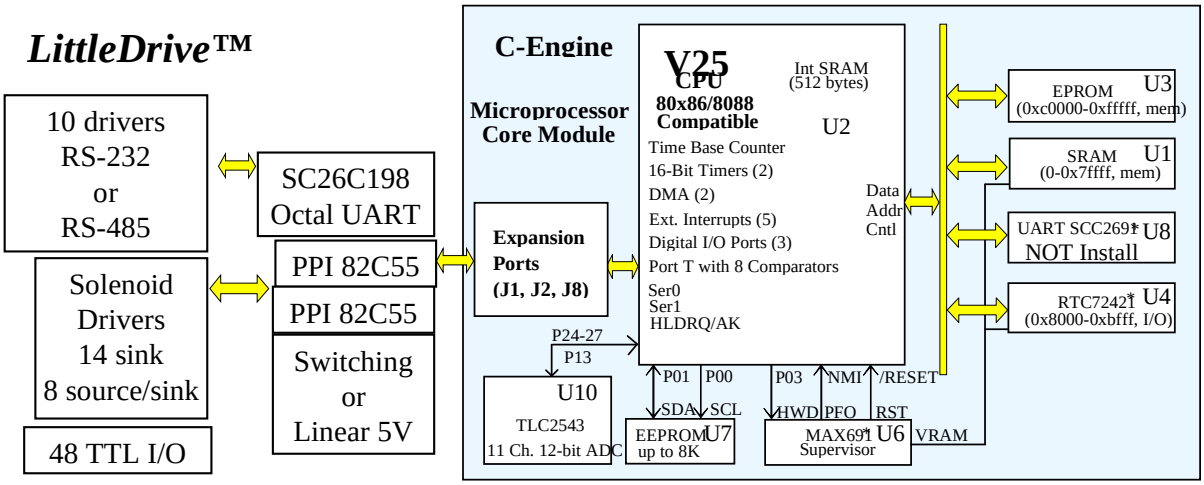


Fig. 1.1. Functional block diagram of LittleDrive™

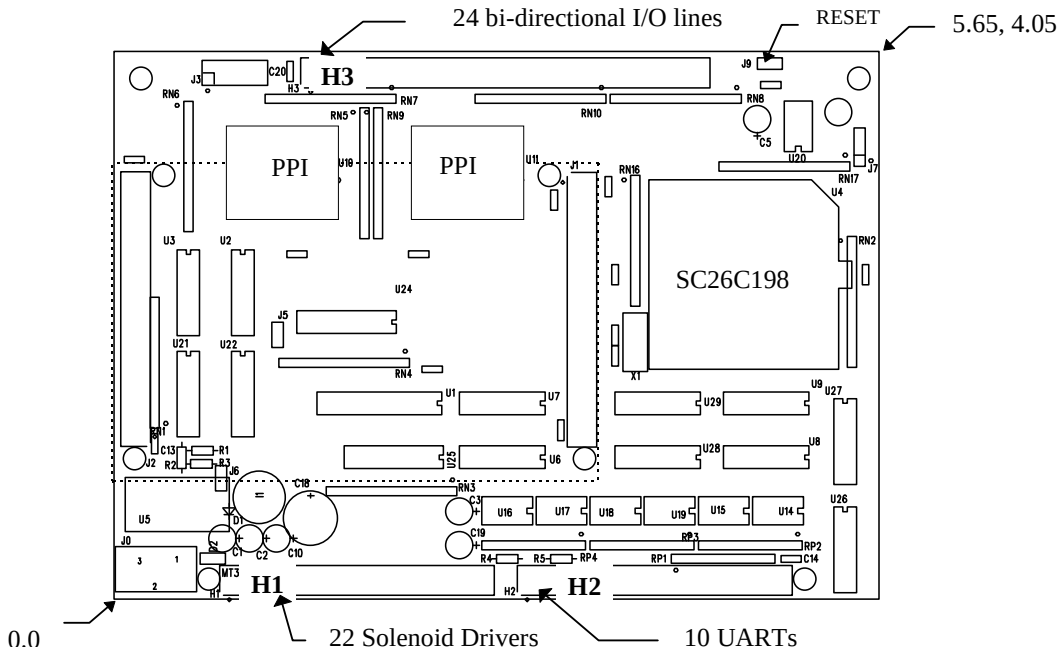


Fig. 1.2. Physical layout of the ***LittleDrive™***

1.3 Physical Description

Fig. 1.2 shows the physical layout of the ***LittleDrive™.*** Table 1.1 is a summary of all the main components used in the ***LittleDrive™.*** The ***LittleDrive™*** is used as an I/O expansion board for the ***V25-Engine™*** or the ***C-Engine™.***

Item	Quantity	Reference	Part
1	7	C1,C2,C3,C4,C5,C10,C19	10UF35V
2	10	C6,C7,C8,C9,C11,C12,C13,C14,C15,C16	0.01UF
3	1	C18	330uf35V
4	3	C20,C21,C22	0.01UF35V
5	2	D1,D2	1N5817
6	4	H1,J1,H2,J2	HDRD40
7	1	H3	HDRD60
8	1	I1	330 uH
9	1	J0	DJ-005
10	1	J3	HDRD10
11	3	J5,J6,J9	HDRD2
12	1	J7	HDRS3
13	1	R1	20K
14	1	R2	2K
15	1	R3	1M
16	3	RP1,R4,R5	120
17	15	RN1,RN2,RP2,RN3,RP3,RN4, RP4,RN5,RN6,RN7,RN8,RN9, RN10,RN16,RN17	10K
18	5	U2,U6,U8,U26,U28	75C189
19	5	U3,U7,U9,U27,U29	75C188
20	1	U4	SC26C198
21	1	U5	LM2575
22	2	U10,U11	PPI8255
23	1	U13	LM7812
24	6	U14,U15,U16,U17,U18,U19	LTC485
25	1	U1	PAL16V8
26	1	U20	ICL7662
27	2	U21,U22	TC4468
28	1	U23	LM340
29	2	U24,U25	ULN2003

Table 1.1 Main Components used in LittleDrive™

1.4 Minimum Requirements

1.4.1 Minimum Hardware Requirements

* A LittleDrive™, including a V25-Engine™ with TERN EPROM (C-Engine-0-xxx);
* A PC-V25™ serial cable with a DB9 connector and an IDC10 connector;
* A center negative wall transformer (+9 V, 500 mA); and a PC or PC compatible computer.

1.4.2 Minimum Software Requirements

* Microsoft Visual C/C++ and MASM6.11, or
* Borland C/C++ 3.1/4.0/4.5, or Borland Turbo C/C++ 3.0 and TASM
* TERN C/C++ Evaluation Kit (EV) or Development Kit (DV)

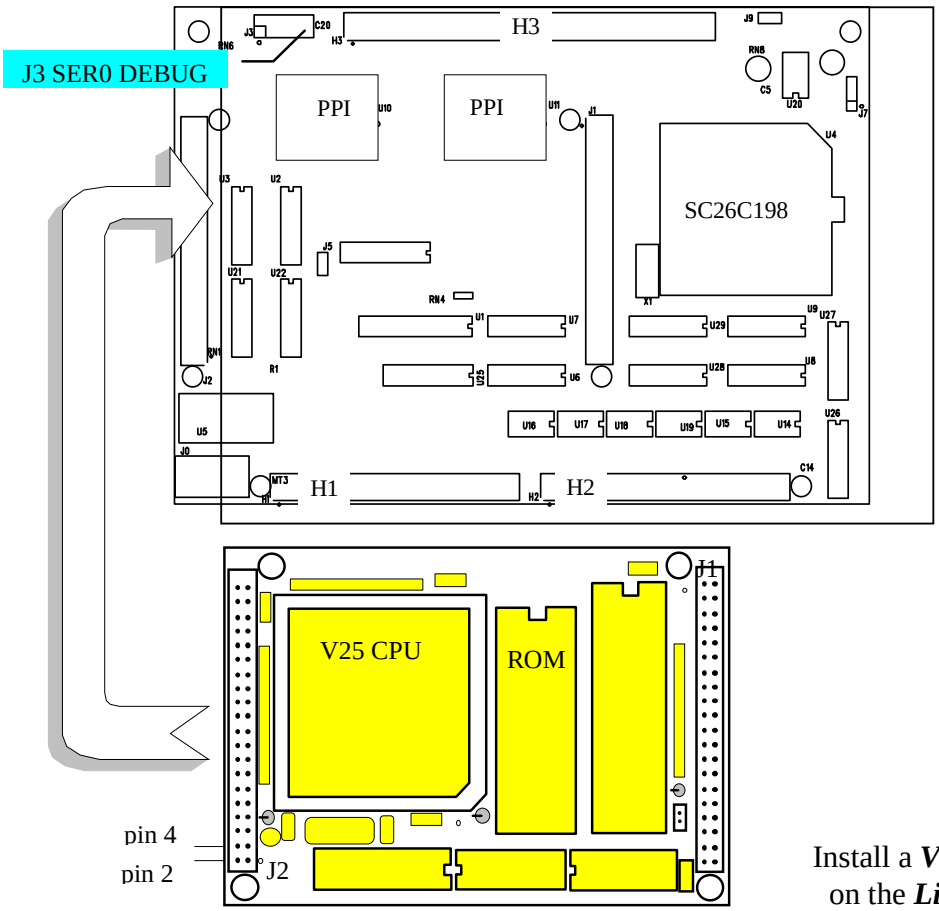
Chapter 2
Installation

2.1 Software Installation

The software installation procedure is the same as that for V25-Engine™, refer to your V25-Engine™ Technical Manual for the details of Software Installation in Chapter 2.

2.2 Hardware Installation

1. Install a V25-Engine™ to the LittleDrive™ via the J1 and J2 (20x2 pin) connector.
Fig. 2.2 shows the orientation of the installation of the V25-Engine™ and LittleDrive™.



Install a ***V25-Engine***™
on the ***LittleDrive***™

2. Plug the IDC 10-pin connector of the PC-V25 serial cable in J3 of LittleDrive (if DENUG EPROM C-Engine-0-xxx is used), making sure that the red side of the cable corresponds to pin 1 of J3, and connect the DB9 connector to PC serial port COM1 or COM2.

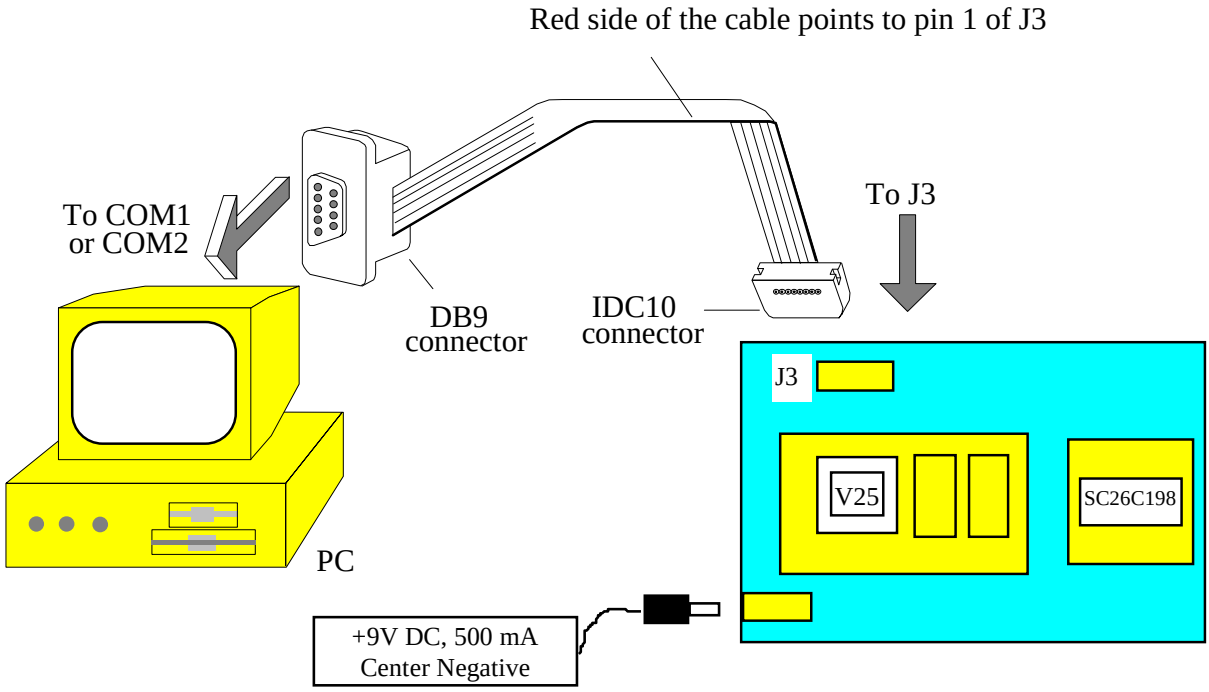


Fig. 2.2. Connection of LittleDrive with the PC

3. Connect the output of the center negative wall transformer (+9V DC) to the LittleDrive DC power jack J0.

Chapter 3
Hardware

3.1 The V25-Engine™, C-Engine™, or A-Engine™

The V25-Engine™, C-Engine™, or A-Engine™ is a microprocessor core module from TERN and is installed in the LittleDrive™. Please refer to the V25-Engine™, C-Engine™, or A-Engine™ Technical Manual for more information.

3.2 V25 I/O pins

Several I/O pins of the V25-Engine™ at J2 are used by the LittleDrive™.
They are assigned for special usage as listed below:

P05 = J2.5	OUTPUT	Source Driver SRC7
P06 = J2.3	OUTPUT	Source Driver SRC8
P15 = J2.29	OUTPUT	Source Driver SRC3
P20 = J2.30	OUTPUT	Source Driver SRC5
P22 = J2.38	OUTPUT	Source Driver SRC4
P23 = J2.24	OUTPUT	Source Driver SRC6
P24 = J2.20	OUTPUT	Source Driver SRC1
P25 = J2.18	OUTPUT	Source Driver SRC2

3.3 LittleDrive I/O Map

Address	Data bits	Symbol	Function
0x20	D0-7	/PI1	Read/Write D0-7 to PPI 82C55 U10 Power on or reset high.
0x40	D0-7	/PI2	Read/Write D0-7 to PPI 82C55 U11 Power on or reset high.
0x60	D0	O1	Write D0 to O1 for SIK4 control Power on or reset low.
0x80	D0	O2	Write D0 to O2 for SIK5 control Power on or reset low.
0xa0	D0	O3	Write D0 to O3 for SIK6 control Power on or reset low.
0xc0	D0	O4	Write D0 to O4 for SIK7 control Power on or reset low.
0xc000	D0-7	E	Original designed for enable SCC2691 UART on the V25-Engine™. For LittleDrive™, NO SCC2691 installed on the VE/CE/AE. “E” enables U4 SC26C198. Read/Write D0-7 to SC26C198 Octal UART

3.4 Octal UART SC26C198

U4 is an Octal UART SC26C198 (Philips, 408 991 3737). It provides 8 full-duplex asynchronous channels with 16 byte FIFOs. Please refer to "ICs for Data Communications" data book from Philips for more details.
In order to provide standard frequency = 3.6864 MHz, the V25-Engine™ or C-Engine™ is using 14.7456 MHz crystal and a special PAL VELD00.jed.

3.5 Logic-input CMOS QUAD Sourcing Drivers

A total of 8 source driver of the two logic-input CMOS quad drivers (TC4468, TelCom) are installed in U21 and U22. The TC4468 drivers can source up to 250 mA into loads reference to ground. They can be used for driving MOSFET in an H-Bridge, or direct driving small motor, relays, or solenoids.

3.6 High-voltage, High-current Sinking Drivers

ULN2003 has high voltage, high current Darlington transistor arrays, consisting of 7 silicon NPN Darlington pairs on a common monolithic substrate. All channels feature open-collector outputs for sinking 350 mA at 50V, and integral protection diodes for driving inductive loads. Peak inrush currents of up to 600 mA sinking are allowed. The outputs may be paralleled to achieve high-load capability, although each driver has a maximum continuous collector current rating of 350 mA at 50V.
The maximum power dissipation allowed is 2.20 W per chip at 25 degree C. The common substrate G is routed to J9 pin1 GND. All currents sinking in must be return from J9 pin 1 GND. A heavy gage(20) wire may be used to connect GND terminal to external power supply ground return. K is connecting to the protection diodes. K should be tied to highest voltage in the external load system. K is connected to J9 pin 2.

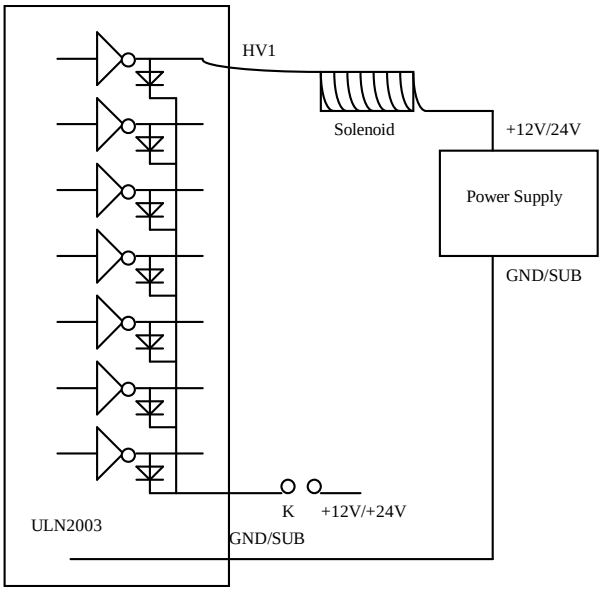


Fig. 4.3 Drive inductive load with high voltage/current drives.

Chapter 4
Software

4.1 Programming the LittleDrive™ with C/C++
Since the LittleDrive™ is only an I/O expansion board driven by a V25-Engine™ or a C-Engine™. Please refer to the V25-Engine Technical Manual for more details.

4.2 Modules in the BB.LIB Library
TERN provides BB.LIB, in addition to the libraries with the V25-Engine™. The BB.LIB has two modules, BB.OBJ and SCC22.OBJ:

Module Name	Include-File Name	Description
BB.OBJ	dos.h, stdio.h, string.h, ve.h, bb.h	module including functions regarding keypad, PDCs, high voltage/current drivers, printer port, beeper, LEDs
SCC22.OBJ	dos.h, stdio.h, string.h, ve.h, scc22.h	module including functions regarding UART SCC22 on the LittleDrive™

LCD functions are listed in the V25-Engine™ Technical Manual

4.3 Functions in BB.OBJ Module

Name	Description
int bb_kb_scan(void);	scan keypad to identify which key is pressed

4.3.2 PDC Functions

int bb_ee_wr(int addr, unsigned char i);	random write a character to an address of EEPROM, PDC0
unsigned char bb_ee_rd(int);	random read a character from an address of EEPROM, PDC0
int bb_ee1_wr(int addr, unsigned char i);	random write a character to an address of EEPROM, PDC1
unsigned char bb_ee1_rd(int);	random read a character from an address of EEPROM, PDC1

4.3.3 LED Function

void bb_led(char n, char i);	turn on red LED if n = 0, i = 1 turn off if n = 0, i = 0 turn on green LED if n = 1, i = 1 turn off if n = 1, i = 0

4.3.4 Beeper Function

void bb_beep(int t, int delay);	beep the beeper for time length = t with frequency = 1/(2*delay*unit)

4.4 SCC2.OBJ
void **scc2_init**(char m, char b, char* ibuf, int isiz, char* obuf, int osiz, COM *c);
initialize SCC2 serial port, where: m = mode, b = Baud rate
ibuf = pointer to input buffer
isiz = size of input data buffer

****

obuf = pointer to output buffer
osiz = size of output data buffer
c = serial data structure, COM
baud - baud rate expressed in units of 1200 baud. (8 == 9600 baud)
baud: 1=1200,2=2400,4=4800,8=9600,16=19200,104=125000,208=250000
mode - 8 bit, 1 stop, no parity, Special mode for Networking, see SCC2691 data sheet

void **scc2_close**(COM *c); Close serial port SCC2
void **clean_ser_scc2**(COM *c); Flush input buffer of SCC2
unsigned char **getser_scc2**(COM *c); get a character from input buffer of SCC2
int **getsers_scc2**(COM *c, int len, unsigned char *str);
get a string from input buffer, where: c = serial data structure, COM, see ve.h
len = max length of input buffer
str = pointer to a buffer for storing the string
return number of characters read or -1 if abort
int **putser_scc2**(unsigned char outch, COM *c);
put a character to the output buffer, return 1, if character output. return 0, if output buffer full
int **putsers_scc2**(unsigned char *str, COM *c);
output a string to output buffer, where str = pointer to the string being output
c = serial data structure, COM
return 1, if character output, return 0, if output buffer full
unsigned char **scc2_rch**void); Receive a character from SCC2 port
void **scc2_sch**(unsigned char dat); Send a character out of SCC2 port
int **serhit_scc2**(COM *c); Check if SCC2 has received anything, return 1, if any, return 0, if nothing
void **scc2_send_e**(void); Enable transmit interrupt for SCC2
void **scc2_rec_e**(void); Enable receive interrupt for SCC2
void **scc2_addr**(unsigned char ad, COM *c); Set SCC2 in the special wakeup mode. where
if ad = 1, set address-byte mode if ad = 0, set data-byte mode
void interrupt far **scc2_s_isr**(void); Interrupt service routine for sending a character to the network
void interrupt far **scc2_r_isr**(void); Interrupt service routine for receiving a character from the network
void interrupt far **scc2_err_isr**(void); Interrupt service routine for error processing

Appendix A: Modifications for A-Engine™ with LittleDrive™

Hardware Modifications on the A-Engine™:

1) cut trace on component side VCC to J2.10

2) add wire between J2.10 to J2.15=P3. NO SCC U8 installed!

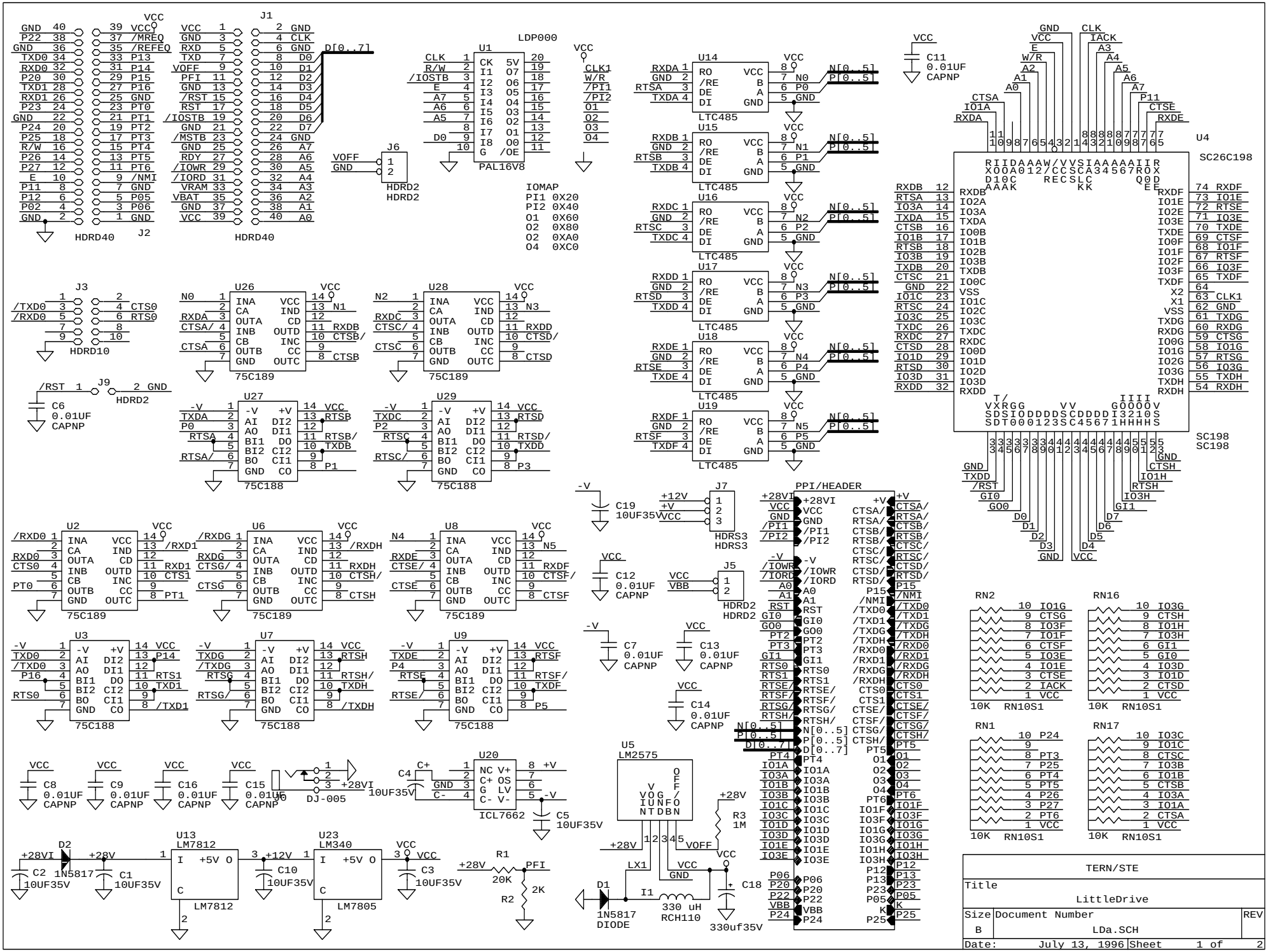
3) add wire bring J1.23=CLK to J1.4=P1

4) destroy C0's one vias that is under the label "C" to disconnect CLK to P1.

Modifications on the LittleDrive™:

1) Install 3.68 MHz crystal.

2) Cut off PAL U1 pin 19, disconnect CLK1 to the crystal.


J2
HDRD40
J1
HDRD40
D[0..7]
J6
VOFF
GND
HDRD2
HDRD2
U1
LDP000
PAL16V8
CLK1
W/R
/PI1
/PI2
O1
O2
O3
O4
IOMAP
PI1 0X20
PI2 0X40
O1 0X60
O2 0X80
O2 0XA0
O4 0XC0
U14
U15
U16
U17
U18
U19
LTC485
N[0..5]
P[0..5]
C11
0.01UF
CAPNP
U4
SC26C198
SC198
SC198
J3
HDRD10
U26
U28
75C189
J9
HDRD2
C6
0.01UF
CAPNP
U27
U29
75C188
J7
HDRS3
HDRS3
J5
HDRD2
HDRD2
PPI/HEADER
C19
10UF35V
C12
0.01UF
CAPNP
C7
0.01UF
CAPNP
C13
0.01UF
CAPNP
C14
0.01UF
CAPNP
U2
U6
U8
U3
U7
U9
75C188
RN2
RN16
RN1
RN17
10K RN10S1
C8
C9
C16
C15
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CAPNP
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U20
ICL7662
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U5
LM2575
R3
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D1
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DIODE
I1
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RCH110
C18
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C2
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C1
10UF35V
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R2
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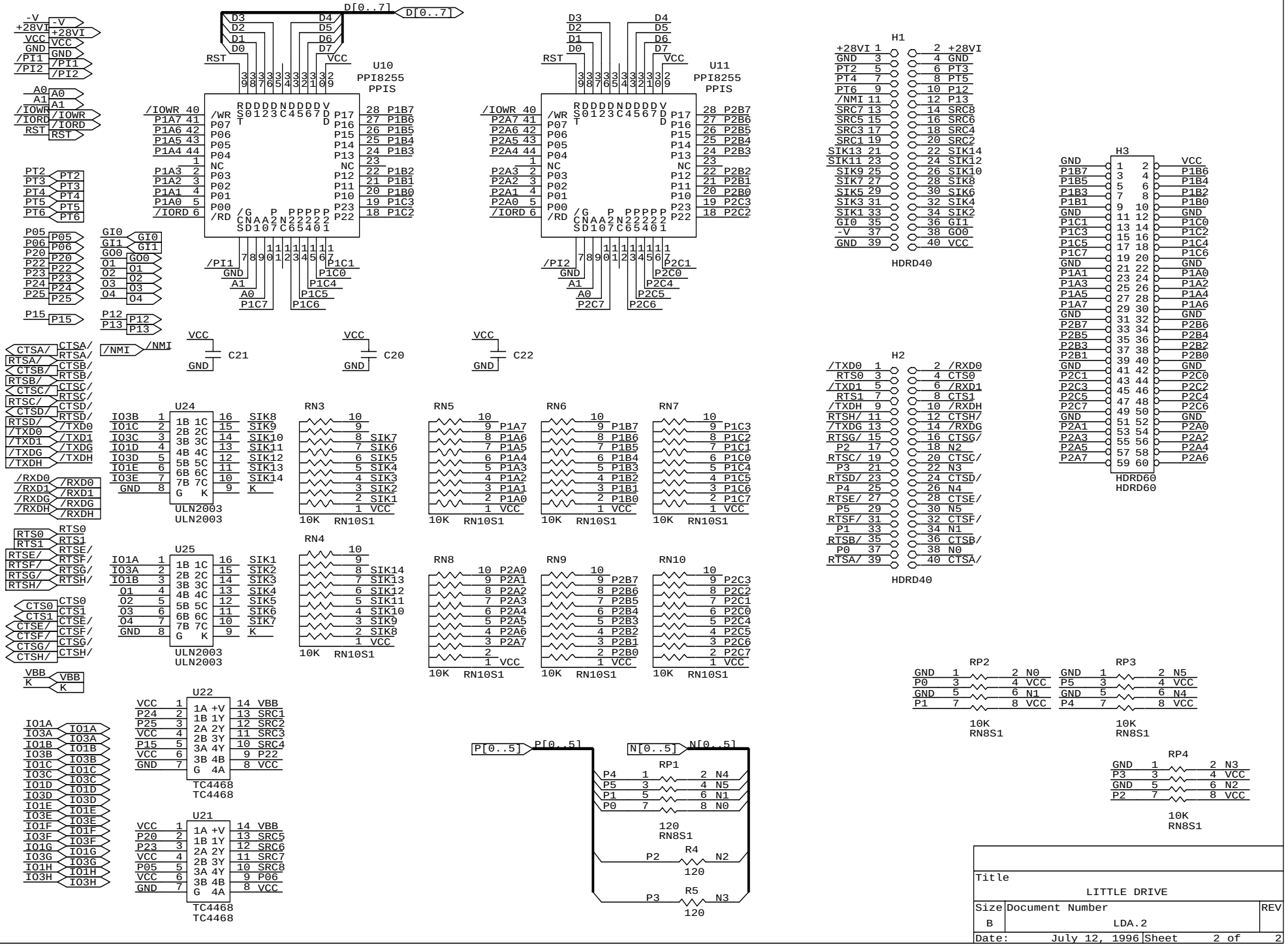
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