# MicroTRAK/P18 Training & Project Kit

for PIC® Microcontrollers

# **User's Guide**

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#### WARRANTY:

BiPOM Electronics warrants MicroTRAK for a period of 1 year. If the product becomes defective during this period, BiPOM Electronics will at its option, replace or repair the product. This warranty is voided if the product is subjected to physical abuse or operated outside stated electrical limits. BiPOM Electronics will not be responsible for damage to any external devices connected to the microcontroller system. BiPOM Electronics disclaims all warranties express or implied warranties of merchantability and fitness for a particular purpose. In no event shall BiPOM Electronics be liable for any indirect, special, incidental or consequential damages in connection with or arising from the use of this product. BiPOM's liability is limited to the purchase price of this product.

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# INTRODUCTION

The PIC® micro-controller, introduced by Microchip in the early 90's, is one of the most popular microcontrollers in use today with applications ranging from industrial, medical, home automation to automotive.

The objective of the MicroTRAK is to give students, engineers, technicians, hobbyists and other users experience with micro-controllers by developing practical applications using C and Assembly language. **The MicroTRAK Lab Book** consists of several labs that vary from simple to complicated.

When used in a school environment, it is recommended that the labs accompany a micro-controller course during the semester. Depending on the duration of each lab during the week, each lab in the student manual can be covered during one or two lab weeks. Based on the remaining time during the semester, the instructor may have the students work on one or more advanced projects. Some advanced project ideas are listed in **Advanced Project Ideas** section of this manual.

This User's Guide is intended for the instructor to get familiar with and setup the MicroTRAK for the upcoming labs. The MicroTRAK Lab Book should be given to each student group in the lab to perform various exercises during the semester.

MicroTRAK can also be used as a Project Kit for rapid prototype development and proof-of-concept. Keypad, LCD, microcontroller board and peripheral boards are already mounted on the carrier board, resulting in a presentable and single-piece assembly for demonstration purposes. LCD and keypad also facilitate software debugging.

MicroTRAK consists of:

- MINI-MAX/P18 Micro-controller Board
- Training Board (TB-1), PROTO-1 Prototyping Board
- LCD with backlight ( adjustable brightness) , matrix keypad
- Carrier board with extra regulator, I/O Module
- MPLAB with Assembler, Debugger and Simulator (free download from Microchip web site)
- Micro-IDE Integrated Development Environment with support for MPLAB from Microchip
- Serial cable, Power Supply
- Example Lab book and this User's Guide

The following external items are required for each Training Kit station:

- Personal Computer (PC) with
- Minimum 128MB memory and 1GB of available hard disk space.
- One available RS232 Serial Port.
- Windows 98/ME/NT/2000/XP/Vista/Windows 7 (32-bit or 64-bit).
- (Optional ) Digital Voltmeter

### INSTALLATION Installing the Hardware

Place MicroTRAK on a clean, non-conductive bench top (preferably on an anti-static mat)

Connect the provided power supply to the power plug on the MicroTRAK . Do not connect the power supply to the outlet yet.

**CAUTION:** Do not use a power supply other than the one that is supplied with the MicroTRAK . Use of another power supply voids the warranty and may permanently **DAMAGE** the board or the computer to which the board is connected !

Make sure the PC is powered off.

Connect one end of the RS232 serial cable to serial connector of MINI-MAX/P18 board as shown on Figure 1.

Connect the other end of the serial cable to your PC's COM port.

Connect the 6VDC power supply to a suitable wall outlet. Power LED on MicroTRAK Carrier Board will turn ON.



Figure 1

### Installing the Software

Software for the system consists of two packages:

- 1. Micro-IDE from BiPOM Electronics: This is a free download.
- 2. MPLAB from Microchip: This is also a free download.

### Micro-IDE

Micro-IDE is an Integrated Development Environment for micro-controller systems application development. Micro-IDE integrates essential components of software development including:

- Multi-File Editor
- Project Manager
- C Compiler, Assembler, Linker
- Optional Micro-controller Simulator
- Terminal program, Calculator, ASCII Chart
- Serial Port Loader

Since Microchip's MPLAB has similar features, we will use MPLAB as our main development environment and use Micro-IDE only as a serial downloader and serial terminal.

Micro-IDE is a part of BiPOM's MC Development System: Download and run *pic\_devsys.exe* from http://www.bipom.com/web\_softwares/318931.html

Welcome	×
	Welcome to the Micro-IDE Setup program. This program will install Micro-IDE on your computer.
	It is strongly recommended that you exit all Windows programs before running this Setup program.
	Click Cancel to quit Setup and then close any programs you have running. Click Next to continue with the Setup program.
	WARNING: This program is protected by copyright law and international treaties.
	Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.
	<u>Next&gt;</u> Cancel

So	ftware l	License Agreement	×
	Z	Please read the following License Agreement. Press the PAGE DOWN key to see the rest of the agreement.	
	END US	SER LICENSE AGREEMENT FROM BIPOM Electronics	
	Please r a legal a ( the "So software Software terms of by copyr laws and	read the following End User License Agreement ("EULA") carefully. The EULA is agreement between you the user and BiPOM Electronics for the use of Micro-IDE oftware"). This EULA contains the conditions under which you may use the e as well as warranty and liability disclaimers. By installing, copying or using the e, you agree to be bound by the terms of this EULA. If you do not agree to the this EULA, do not install, copy, or use the Software. This Software is protected right laws and international copyright treaties, as well as other intellectual property d treaties. This Software is licensed, not sold.	
	For more program	e information about Micro-IDE, see the About box under Help menu in this . To learn more about BiPOM Electronics and its products, visit	
	Doyoua will close	accept all the terms of the preceding License Agreement? If you choose No, Setup a. To install Micro-IDE, you must accept this agreement.	
		< <u>B</u> ack <u>Y</u> es <u>N</u> o	

Please read the agreement and click Yes to continue.

Enter your name, company and 'FREE' as a serial number. Then click the Next button.

User Information			×
User Information	Please ente You may lea size-restricto N <u>a</u> me: <u>C</u> ompany: <u>S</u> erial:	er your name, company name and serial number below. ave the serial number field blank to run this software in ed demo mode. Jack bipom FREE	×
		< <u>B</u> ack <u>N</u> ext > Cancel	

Select the disk location where the software has to be installed. The default location (c:\bipom\devtools) is recommended. Click the Next button to start the installation.

Choose Destination Loca	tion
	Setup will install Micro-IDE in the following folder. To install to this folder, click Next. To install to a different folder, click Browse and select another folder. You can choose not to install Micro-IDE by clicking Cancel to exit Setup.
	Destination Folder C:\bipom\devtools
	< <u>B</u> ack <u>N</u> ext > Cancel

Click Next. Select the Program Folder where the icons for Micro-IDE will be installed. Default selection is **Micro-IDE** folder:

Select Program Folder		×
Select Program Folder	Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the existing Folders list. Click Next to continue. Program Folders: Micro-IDE Existing Folders:	
	Microchip	1
	Micro-IDE Microsoft Office	-
	Microsoft Office Tools Microsoft Platform SDK Eshavara 2002	
	Microsoft Visual Studio 6.0	1
	ModbusConstructor Mozilla Firefox	
	Mozilla Thunderbird	]
		-
	< <u>B</u> ack <u>N</u> ext > Cancel	

Click Next. Micro-IDE will be installed.



Setup Complete	
	Setup has finished installing Micro-IDE on your computer.
	Setup can launch the Read Me file and Micro-IDE. Choose the options you want below.
	U would like to launch Micro-IDE.
	IMPORTANT NOTE: If you have other development systems that use Micro-IDE, please make sure to update all other development systems to the latest versions from BiPOM web site to avoid unexpected behavior.
	< <u>B</u> ack. <b>Finish</b>

Uncheck the "I would like to launch Micro-IDE" option and click the Finish button.

### MPLAB

Download and install the latest **MPLAB® IDE** from **Microchip®** website. The location of MPLAB on Microchip web site may change from time to time. To find the latest MPLAB, please visit <u>www.microchip.com</u> first. Select Development Tools from Design tab:

<b>Міскоснір</b>	-A Leading	g Provider of Microcontrollers & Analog	myMicrochip Login   English   Chinese 中文   Japanese 日本語 Semiconductors Search: GO »		
Home Products	•	Design <b>Design</b>	Applications  Buy/Sample  Corporate  What's New		
Home  Products Home Page  Develop	oment Too	Getting Started	•		
Other Links	MPLA	Technical Documentation	Environment		
Buy/Sample Options SW007002	Part Nu	Design & Simulation Tools	•		
Contact Microchip		Application Notes & Software			
O Development Tool Selector	<u>Go to t</u> l	Software Libraries	AB <sup>®</sup> IDE downloads		
<ul> <li>Microchip Advanced Parts</li> <li>Advanced Parts</li> </ul>	What is	Code Examples			
Selector (MAPS)	MPLAE	Programming	ent (IDE) is a free, integrated toolset for the development of embedded applications employing		
	Microck	Microchip Videos	ers. MPLAB IDE runs as a 32-bit application on MS Windows®, is easy to use and includes		
	a host o	Development Tools	application development and super-charged debugging. MPLAB IDE also serves as a sime I Microchin and third party software and hardware development tools. Moving between too		

Select Development Tools

#### Download MPLAB IDE:

In-Circuit Emulator & Debuggers	Programmers
MPLAB Emulators & Debuggers Processor Modules Device Adaptors Adapter Kits Cables	Getting Started Programmers Programmers Socket Modules Programming Adaptors
Accessories	Demo, Evaluation Kits & Reference Design
Emulator – Debugger Accessories Headers Transition Sockets	PIC <sup>®</sup> MCU PIC24 MCU PIC32 Boards and Kits dsPIC Boards and Kits
Software	PICtail™ Plus Daughter Boards
MPLAB® IDE Application Libraries Compilers RTOS Software Archives	PICtail™ Daughter Boards Analog Boards and Kits Security General Purpose Motor Control Automotive Wireless Connectivity
Starter Kits	Wired Connectivity
Starter Kits	Power Graphics Memory
	Low Power Development Boards

Latest Proc	duction Release: MPLAB IDE ∨8.56		
New in MPLAB IDE ∨8.56:			
The most recent full release of MPLAB IDE introduce	es these new features:		
These new features are added to MPLAB IDE	v8.56 (new device support is listed in the Release Note	es):	
New part support – See Release Notes for d	letails.		
Bug fixes –			
Archived versions of older MPLAB IDE software are available <u>here</u> . If you have problems with the installation check <u>http://consumer.installshield.com</u> . If you have any difficulties downloading any of these files, please e-mail webcorrections@microchip.com			
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u>		
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software		
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these <b>Downloads</b>	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software Associated Files and Release Notes		
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these <b>Downloads</b> MALAB IDE V6.56 Full Release Zipped Installation MALAB IDE V6.56 Full Release Zipped Installation	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software Associated Files and Release Notes Release Notes for MPLAB IDE v8.56		
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these <b>Downloads</b> MPLAB IDE v8.56 Full Release Zipped Installation MATLAB DOE v8.56 Full Release Zipped Installation	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software Associated Files and Release Notes Release Notes for MPLAB IDE v8.56		
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these Downloads MPLAB IDE v8.56 Full Release Zipped Installation MATLAB Device Blocks for dsPIC DSCs Downloads	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software Associated Files and Release Notes Release Notes for MPLAB IDE v8.56		
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Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these <b>Downloads</b> MPLAB IDE v8.56 Full Release Zipped Installation MATLAB Device Blocks for dsPIC DSCs <b>Downloads</b> Title MPASM/MPLINK User's Guide	available <u>here</u> . <u>://consumer.installshield.com</u> . files, please e-mail <u>webcorrections@microchip.com</u> <b>MPLAB Software</b> <u>Associated Files and Release Notes</u> <u>Release Notes for MPLAB IDE v8.56</u> <u>Date Published</u> <u>4/8/2009 3:52:41 PM</u>	<b>Size</b> 2896 КВ	D/
Archived versions of older MPLAB IDE software are a If you have problems with the installation check <u>http:</u> If you have any difficulties downloading any of these <b>Downloads</b> (MPLAB IDE v8.56 Full Release Zipped Installation) MATLAB Device Blocks for dsPIC DSCs Downloads Title MPASM/MPLINK User's Guide MPLAB Assembler, Linker and Utilities for PIC24 MCUs	available <u>here</u> . ://consumer.installshield.com. files, please e-mail <u>webcorrections@microchip.com</u> MPLAB Software Associated Files and Release Notes Release Notes for MPLAB IDE v8.56 Date Published 4/8/2009 3:52:41 PM s and dsPIC DSCs User's Guide 1/26/2010 10:16:32 AM	<mark>Size</mark> 2896 КВ 1981 КВ	DA D
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When you click on the link, zip file will start downloading:

🔮 75% of 1 file - Downloads			
MPLAB_IDE_v8_56.zip		<u>^</u>	
	08		
3 minutes, 19 seconds remaining — 74.6 of 98.3 MB (108 KB/sec)			

Extract the contents of the zip file to a temporary directory ( for example,  $c:\$ ) and run **setup.exe** from within the zip file:

MPLAB_IDE_v8_56.zip					
<u>File E</u> dit <u>V</u> iew F <u>a</u> vorites <u>T</u> ools	Help				
🕝 Back 🔹 🕥 👻 🏂 🔎 Se	arch 😥 Folders 🛄 🗸				
Address 📳 C:\DOCUME~1\oguz\LOCAL	5~1\Temp\MPLAB_IDE_v8_56.zip				
Folder Tasks 🛞	🗃 🖄 🔂 🗖				
Other Places 🙁	Data1.cab ISSetup.dll MPLAB Tools mplabcert.bmp setup.exe v8.56.msi				
<ul> <li>Temp</li> <li>My Documents</li> <li>Shared Documents</li> <li>My Network Places</li> </ul>					

MPLAB Installation will start:





Click Next. Accept the license agreement:

MPLAB® Tools	×
MPLAB IDE License Agreement	P
IMPORTANT. MICROCHIP IS WILLING TO LICENSE THE MPLAB <sup>®</sup> IDE SOFTWARE AND ACCOMPANYING DOCUMENTATION OFFERED TO YOU ONLY ON THE CONDITION THAT YOU ACCEPT ALL OF THE FOLLOWING TERMS. TO ACCEPT THE TERMS OF THIS LICENSE, CLICK "I ACCEPT" AND PROCEED WITH THE DOWNLOAD OR INSTALL. IF YOU DO NOT ACCEPT THESE LICENSE TERMS, CLICK "I DO NOT ACCEPT," AND DO NOT OPEN DOWNLOAD OR INSTALL THIS SOFTWARE. MPLAB <sup>®</sup> IDE LICENSE	
I do not accept the terms of the license agreement	
< <u>B</u> ack <u>N</u> ext > Cancel	)

Click Next.

MPLAB® Tools		
Setup Type Select the setu	up type to install.	<b>Міскоснір</b>
Please select	a setup type.	
	All program features will be installed. (Requires the mo	ost disk space.)
O Custom	Select which program features you want installed. Re advanced users.	commended for
	< <u>B</u> ack	Next > Cancel

Select Complete. Click Next.

MPLAB® Tools	X
Choose Destination Location Select folder where setup will install files.	<b>Міскосні</b> р
Setup will install MPLAB Tools v8.56 in the following folder.	
To install to this folder, click Next. To install to a different fo another folder.	lder, click Browse and select
Destination Folder	
C:\Program Files\Microchip\	B <u>r</u> owse
< <u>B</u> ack	Next > Cancel

Click Next to install to default location.

MPLAB® Tools
Application Maestro License <b>Signal Application Maestro License</b>
MAESTRO® SOFTWARE LICENSE AGREEMENT
YOU ARE PERMITTED TO ACCESS THE SOFTWARE AND DOCUMENTATION ONLY IF YOU ACCEPT THE TERMS AND CONDITIONS OF MICROCHIP'S "NON-EXCLUSIVE LICENSE AGREEMENT FOR MAESTRO <sup>®®</sup> SOFTWARE" (HEREAFTER, THE "AGREEMENT").
IF YOU AGREE TO THE TERMS OF THE AGREEMENT, INDICATE 🐱
<ul> <li>         I accept the terms of the license agreement      </li> <li>         I do not accept the terms of the license agreement      </li> </ul>
< <u>B</u> ack <u>N</u> ext > Cancel

Accept the agreement and click Next.

MPLAB® Tools
IMP ORTANT:         MICROCHIP IS WILLING TO LICENSE THE MPLAB® C COMPILER FOR         PIC32 MCUS SOFTWARE AND ACCOMPANYING DOCUMENTATION         OFFERED TO YOU ONLY ON THE CONDITION THAT YOU ACCEPT ALL OF         THE FOLLOWING TERMS. TO ACCEPT THE TERMS OF THIS LICENSE,         CLICK "I ACCEPT" AND PROCEED WITH THE DOWNLOAD OR INSTALL.         IF YOU DO NOT ACCEPT THESE LICENSE TERMS, CLICK "I DO NOT         ACCEPT," AND DO NOT DOWNLOAD OR INSTALL THIS SOFTWARE.         NON-EXCLUSIVE SOFTWARE LICENSE AGREEMENT         FOR MICROCHIP MPLAB© C COMPILER FOR PIC32 MCUS SOFTWARE         I accept the terms of the license agreement         Pint
< <u>B</u> ack <u>N</u> ext > Cancel

Accept the agreement and click Next.

MPLAB® Tools	
Start Copying Files Review settings before copying files.	🔨 Міскоснір
Setup has enough information to start copying t change any settings, click Back. If you are sat copying files. Current Settings:	he program files. If you want to review or isfied with the settings, click Next to begin
Destination Directory: C:\Program Files\Microchip\ Setup type selected: Complete Components selected: Serial Memory Devices 8-bit MCUs and KeeLog devices. 16-bit MCUs and DSCs 32 bit MCUs REAL ICE CMD	
InstallShield	A Mext > Cancel

Click Next.

Installation will start:

MPLAB® Tools	×
Setup Status	<b>Міскоснір</b>
MPLAB Tools v8.56 is configuring your new software installation.	
Validating install	
	Cancel

The installation program may ask you to install HI-TECH C after the MPLAB installation is complete. It is OK to click Yes and install HI-TECH C although it is not needed for the purpose of this User Guide.

At the end of installation, you may be asked to restart your computer. Make sure that all your open programs are closed and your data is saved and click Finish restart your computer:

MPLAB® Tools		
A REAL PROPERTY OF THE REAL PR	InstallShield Wizard Complete The InstallShield Wizard has successfully installed MPLAB Tools v8.56. Before you can use the program, you must restart your computer. • Yes, I want to restart my computer now. • No, I will restart my computer later. Remove any disks from their drives, and then click Finish to complete setup.	
	< <u>B</u> ack <b>Finish</b> Cancel	

After your computer restarts, you can start MPLAB from Start->Programs:



### **Opening Projects**

MC Development System is distributed with several example programs that illustrate how to program the  $\mbox{PIC}\xspace{\mbox{B}}$  micro-controller.

To open the example projects, start MPLAB and select Project menu. Select Open.

Project	<u>D</u> ebugger	Programmer	<u>T</u> ools	⊆onfi
Projec	t Wizard			
New				
Open				
Close				•
Set A	ctive Project	:		•
Quick	build (no ,as	m file)		
Packa	ige in .zip			
Clean				
Expor	t Makefile			
Build #	411		Ctrl+F1	.0
Make			F10	
Build	Configuratio	n		- <b>F</b>
Build	Options			<u> </u>
Save	Project			
Save	Project As			
Add F	iles to Proje	ct		
Add N	lew File to P	roject		
Remo	ve File From	Project		•
Select	: Language "	Foolsuite		
Set La	anguage Too	l Locations		
Versio	on Control			

PIC18 example projects are located under the path:

#### \bipom\devtools\MPASM\Examples\pic18

Select the project **io.mcp**:

Open Project		? ×
Look in: 📔	io 🔽 🗿 🌶 (	≫ ⊞•
📉 io.mcp		
File name:		Open
-		Consel
Files of type:	MPLAB IDE Project Files (*.mcp)	Lancei
Jump to:	D:\bipom\devtools\MPASM\Examples\pic1{	
		///

n io - MPLAB IDE v8.56 - io.mcw File Edit View Protect Debugger Programmer Tools Configure Window Help	
🗅 😂 🖬   🐇 🐂 🖷   🍜 🗚 🇯 🚚 📕 😵 📔 Debug 👻 🗗 🔛 📾 😨 🔛 🚳 📾 🚺 Checksum:0x82d7	
Buld       Version Control       Find in Files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the files       Image: Control of the files         Image: Control of the file	
PIC18F458 W:0 n ov z dc c bank 0 bank 0	

MPLAB will open the project and display the Project View:

Double click on *io.asm* to open the source file:





The *io.asm* assembly language source file will appear:

\_ 🗆 × D:\bipom\devtools\MPASM\Examples\pic18\io\io.asm ż ٠ 2 2 ;\*\*\*\*\*\*\* list p=18f458 ; list directive to def #include <pl8F458.inc> ; processor specific variable d CONFIG OSC = HS , BOR = ON , BORV = 45 , WDT = OFF, STVR = ON ; Program starts here ; Turn comparator function off on PORT D MOVLW 07h MOVWE CMCON ; Set all PORT D pins as outputs ; Writing a 0 to a TRISD bit makes the corresponding port p-MOVLW 5'00000000' MOWWE TRISD ; Loop forever ;Make all PORT D outputs logic O CLRF PORTD loop MOVLW Б'11111111 ;Put FFh into accumulator MOVWE ;Make all PORT D outputs logic 1 PORTD GOTO ;Loop loop END 11

You can scroll down to see the assembly instructions of io.asm:

Select Project->Build All to build the project:



The project will build, *io.asm* file will be compiled and an *io.hex* output file will be generated. The results of the Build are displayed in the Build Window:

🗖 Output	×
Build Version Control Find in Files	
Debug build of project `D:\bipom\devtools\MPASM\Examples\pic18\io\io.mcp' started. Language tool versions: MPASMWIN.exe v5.37, mplink.exe v4.37, mplib.exe v4.37 Preprocessor symbol `DEBUG' is defined. Sun Sep 19 19:32:59 2010	
Clean: Deleting intermediary and output files. Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.o". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.er". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.hex". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.lst". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.of". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.of". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.of". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.cof". Clean: Deleted file "D\bipom\devtools\MPASM\Examples\pic18\io\io.mcs".	
Executing: "D:\Program Files\Microchip\MPASM Suite\MPASMWIN.exe" /q /p18F458 "io.asm" /l"io.lst" /e"io.err" /dDEBUG=1 Executing: "D:\Program Files\Microchip\MPASM Suite\mplink.exe" /p18F458 "io.o" /u_DEBUG /zMPLAB_BUILD=1 /zMPLAB_DEBUG= MPLINK 4.37, Linker Copyright (c) 1998-2010 Microchip Technology Inc. Errors : 0	
Debug build of project `D:\bipom\devtools\MPASM\Examples\pic16\to\to\to\to\to\to\to\to\to\to\to\to\to\	
BUILD SUCCEEDED	-

### **Downloading Programs**

To download projects, Micro-IDE is used. We have created project files for both Micro-IDE and MPLAB for all the PIC® examples. The code can be developed and simulated in MPLAB and downloaded to the actual hardware using Micro-IDE. Micro-IDE also has a terminal emulator window that allows monitoring the RS232 serial output from the MINI-MAX/P18 board.

Start Micro-IDE by selecting Start, Programs and Micro-IDE. Select the Micro-IDE option under Micro-IDE folder. This will start Micro-IDE.

🛱 Accessories	<b>•</b>
👼 Micro-IDE	🕨 🛃 Help for Micro-IDE
💼 Microsoft Visual Studio 6.0	Micro-IDE
Microsoft Access	🕘 Help for Basic Compiler BASCOM-8051
Microsoft Excel	

When Micro-IDE is started, the Project selection window appears:

Welcome	×			
Welcome to Micro-IDE Program Development Environment.				
What do you want to start with:				
C Create a new project	Cancel			
Open existing project	OK			
Show this dialog at startup.				

Click Cancel for this first time because you will first configure communications before opening a project.

After you have started Micro-IDE, configure the correct COM port and communications parameters:

1. Select Tools and Options from the Micro-IDE menu.

2. Under Terminal tab, make sure Com Port is selected as the port that you connected to the MINI-MAX/P18 board. For example, if the board is connected to COM1, select COM1 under Terminal tab. Make sure that the Terminal options are set as follows:

Baud Rate: 19200 Data Bits: 8 Stop Bits: 1 Parity: None Echo: Off

3. Under Loader tab, make sure Com Port is selected as the port that you connected MINI-MAX/P18 board. For example, if the board is connected to COM1, select COM1 under Loader tab. Make sure that the Loader options are set as follows:

Baud Rate: 19200 Data Bits: 8 Stop Bits: 1 Parity: None Echo: Off

4. Open the Terminal window by selecting Terminal under View menu. A blank terminal screen will appear on the right side of the Micro-IDE window. (You can resize the terminal screen by selecting the left edge of the terminal window with the left mouse button and dragging to the right.).

5. Check communications to the MicroTRAK. Start the Terminal program by selecting Terminal under View menu. A blank terminal screen will appear on the right side of the Micro-IDE window. (You can resize the terminal screen by selecting the left edge of the terminal window with the left mouse button and dragging to the right.)

6. Select Tools, Terminal and Connect. This will open the COM port and connect the terminal to the MINI-MAX/P18.

Make sure the MINI-MAX/P18 board is powered and connected to the PC as described in the section **Installing the Hardware**.

Open the *io.prj* project that is under:

\bipom\devtools\MPASM\Examples\pic18

Open		<u>? ×</u>
Look in: 📔	) io	- 🔁 🖆 🎫
io.prj		
File name:		Open
The Hame.		
Files of <u>type</u> :	Project files (*.prj)	Cancel

Download the file to the board by selecting Download under Build menu:



If the board is powered and connected properly to the PC, a progress dialog will appear:

Downloading program	×
47%	
Cancel	

The progress dialog will disappear following a successful download. Details of the download are shown on the Output Window:

Success writing 32 bytes
Success writing 32 bytes
Success writing 26 bytes
•
Build Debug Find in Files 1 Find in Files 2 Loader

When the download is finished, the progress indicator disappears. This means that the board has received the program successfully.

After the program has been successful downloaded, it can be started using the Mode button on the main Toolbar:



Mode button puts the board into **Run** or **Program** mode. In Run mode, the micro-controller is executing the program in its memory. In Program mode, the micro-controller is in Reset state so no programs are running. In Program mode, micro-controller's flash memory can be changed and a new program can be downloaded.

The Mode button is Red in Program mode and Green in Run mode. Following a download, the Mode button will be Red. Click the Mode button to change the mode to Run mode. The program **io.hex** that you just downloaded starts executing.

The program **io.hex** will blink the LED's that are connected to PORT D on MicroTRAK's I/O Module.

#### Congratulations!!! You have built and executed your first program on MicroTRAK.

Click the Mode button once again so it turns Red. The board is in Program mode now and it will stop running and the LED's will not blink any more.

# **Creating Projects**

To create your own project, start MPLAB. Select Project->New:

Project	Debugger	Programmer	То
Proje	ct Wizard…		
New.			
Open			
Close			•
Set A	ctive Project	:	×
Quick	build (no .as	m file)	
Packa	ige in ,zip		
Clean			
Build (	Configuratio	n	•
Build	Options		×
Save	Project		
Save	Project As.,	,	
Add F	iles to Proje	ct	
Add N	Jew File to P	roject	
Remo	ve File From	Project	×
Select	t Language 1	Foolsuite	
Set La	anguage Too	Locations	
Versio	on Control		

Specify project name and location:

New Project		×
Project Name test		
Project Directory		Browse
Help	OK	Cancel

Click OK.

Create a new file by selecting File->New:

<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	Project	<u>D</u> ebugger	Progra
N	ew			Ctrl+N	
A	dd Nev	v File to	Project.		
0	pen			Ctrl+O	
C	lose			Ctrl+E	
Si	ave			Ctrl+S	
Sa	ave As				
S	ave All			Ctrl+Shift	t+S
0	pen W	orkspa	ce		
Sa	ave Wi	orkspac	:e		
Sa	ave W	orkspac	:e As		
C	lose W	orkspa	ce		
In	nport				
E	xport				
Pr	rint			Ctrl+P	
R	ecent l	Files			•
R	ecent	Worksp	aces		•
E	xit				

MPLAB will open a new window and show the empty file:



Select File->Save As:

<u>F</u> ile	Edit	⊻iew	Project	<u>D</u> ebugger	Progra
N	ew			Ctrl+N	
A	dd Nev	v File to	) Project		
0	pen			Ctrl+O	
C	lose			Ctrl+E	
S	ave			Ctrl+S	
S	ave As				
S	ave All			Ctrl+Shift	:+5
O Si Si C	pen W ave W ave W lose W	'orkspa orkspac orkspac 'orkspa	ce :e :e As ce		
In	nport.				
E	xport.				
P	rint			Ctrl+P	
R	ecenti	Files			•
R	ecent	Worksp	aces		•
E	xit				

Save the file as *test.asm* to c:\test folder:

Save As			? ×
Savejn: 问	test 🔽 🕑 🤣	جي 🤧	
I			
File <u>n</u> ame:	test.asm	<u>S</u> ave	•
Save as <u>type</u> :	Assembly Source Files (*.asm;*.as;*.inc;*.s)	Cano	el
lump to:	D:\bipom\devtools\MPASM\Examples\pic1		
oumpito.			
Encoding:	ANSI		
	Add File To Project		1.

Click Save.

Now add this new file test.asm to the test project. Select Project->Add Files to Project:



Select test.asm from c:\test to add to the project:

Add Files to P	roject	<u>? ×</u>
Look jn: 🜔	test 💽 🕝 🦻	⊳ 🖽
test.asm		
, File <u>n</u> ame:	test.asm	<u>O</u> pen
Files of type:	Assembly Source Files (*.asm)	Cancel
Jump to:	C:\test\	
	ber this setting	
Auto: Le	et MPLAB IDE guess	
O User: Fi	le(s) were created especially for this project, use relativ	ve path
C System:	File(s) are external to project, use absolute path	

Click Open.

In the test.asm source file window, type the following to configure the program for PIC18F458 microcontroller:

list p=18f458

#include <p18F458.inc>

#### CONFIG OSC = HS, BOR = ON, BORV = 45, WDT = OFF, STVR = ON

**Note:** When typing, put a tab character before each line in the assembler. Otherwise you may get warnings from the assembler.

list command specifies the microcontroller type as PIC18F458

**#include** defines the include file to include in this project. In this case, we use the include file p18F458.inc that contains the PIC18F458 specific register names and definitions.

**CONFIG** command specifies the special hardware configuration values for PIC18F458. In this case:

OSC = HS ( this means, we selected high speed crystal as the clock source )

BOR = ON ( this means that Brownout detect feature is enabled )

**BORV = 45** ( this means that the Brownout value is set at 4.5 Volts, supply voltages below 4.5 Volts will results in microcontroller reset )

WDT = OFF (Watchdog timer is disabled)

STVR = ON ( A stack overflow will reset the PIC18F458 )

The resulting source file window will look like this:

C:\test\test.asm*	
list p=18f458	<b>^</b>
<pre>#include <pl8f458.inc></pl8f458.inc></pre>	
CONFIC OSC = HS , BOR = ON , BORV = 45 , WDT = OFF, STVR = ON	

Now type the following small assembly language program:

movlw b'00000000' movwf TRISC

movlw b'11111111' movwf PORTC

**b** is the symbol for binary notation. For example, **b'11111110'** is the equivalent of **254** decimal or **FE** hex.

TRISC is the data direction register for I/O PORT C. PORTC is the data register for I/O PORT C.

This simple program sets first bit of PORT C ( also referred to as RC0 ) as an output and then clears this bit.

Finally, add the keyword **END** at the end of your program to tell the assembler where the program ends. The resulting source file will look like this:

\_ 🗆 × c:\test\test.asm \* list p=18f458 #include <pl8F458.inc> CONFIG OSC = HS , BOR = ON , BORV = 45 , WDT = OFF, STVR = ON Ъ'00000000' movlw TRISC movwf movlw b'11111110' movwf PORTC END 

Save the file by selecting File->Save.

The next step is to build the project. Select Project->Build All:



On the first build, MPLAB will prompt with the following question:

Absolute or Relocatable?	×
Do you want this project to generate (You can change this later in the Buil	absolute or relocatable code? Id Options dialog on the `Suite' tab.)
Absolute	Relocatable

Select Absolute.

MPLAB will open the Build Window and build the project successfully if the source file was typed correctly:

Output
Build Version Control Find in Files
Debug build of project `c:\test\test.mcp' started. Language tool versions: MPASMWIN.exe v5.37, mplink.exe v4.37, mplib.exe v4.37 Preprocessor symbol `DEBUG' is defined. Sun Sep 19 22:35:58 2010
Clean: Deleted file "C\test\test.o". Clean: Deleted file "C\test\test.o". Clean: Deleted file "C\test\test.o". Clean: Deleted file "C\test\test.or". Clean: Deleted file "C\test\test.of". Clean: Deleted file "C\test\test.of". Clean: Done. Executing: "D\Program Files\Microchip\MPASM Suite\MPASMWIN.exe" /q /p18F458 "test.asm" /!"test.lst" /e"test.err" /dDEBUG=1 Executing: "D\Program Files\Microchip\MPASM Suite\MPASMWIN.exe" /q /p18F458 "test.asm" /!"test.lst" /e"test.err" /dDEBUG=1 Executing: "D\Program Files\Microchip\MPASM Suite\mplink.exe" /p18F458 "test.o" /u_DEBUG /zMPLAB_BUILD=1 /zMPLAB_DEBUG=1 /o"test.cof" /M MPLINK 4.37. Linker Copyright (c) 1998-2010 Microchip Technology Inc. Errors : 0
Loaded c:\test\test.cof.
Debug build of project "c:\test\test.mcp" succeeded. Language tool versions: MPASMWIN.exe v5.37, mplink.exe v4.37, mplib.exe v4.37 Preprocessor symbol `DEBUG' is defined. Sun Sep 19 22:36:01 2010
BUILD SUCCEEDED

The successful build generates several files, including *test.hex* which is the output file that will be downloaded to the MINI-MAX/P18 board.

#### Simulation

You can simulate the micro-controller and single-step through your program without actually having the MINI-MAX/P18 connected to your PC. MPLAB has a built-in PIC® microcontroller simulator

To start the simulation, first specify the simulator/debugger to use by selecting Debugger->Select Tool->MPLAB SIM. MPLAB SIM is the simulator that is built-in to MPLAB.



We will start the simulation by resetting the 18F458 microcontroller ( in simulation mode ). Select Debugger->Reset->Processor Reset:



This will reset the simulated microcontroller and place the current program position indicator ( Program Counter ) on the first executable line of code:

```
c:\test\test.asm
                                                                         - 🗆 ×
                                                                              .
            list
                      p=18f458
            #include <pl8F458.inc>
            CONFIG OSC = HS , BOR = ON , BORV = 45 , WDT = OFF, STVR = ON
   ⇒
                    Ъ'00000000'
           movlw
           movwf
                    TRISC
                    Ъ'11111110'
           movlw
                    PORTC
           movwf
            END
•
```

The green arrow shows the current instruction that is about to be executed.

Selecting the Debugger menu, you will notice that there are keyboard shortcuts for Simulator operations:

F7 for Step Into F8 for Step Over F9 for Run F2 for Breakpoints

These keyboard shortcuts are faster and easier to use than menu operations and are recommended.

Press F7 and the green arrow will move to the next executable instruction:



To view the simulated PIC18F458 registers, select View->Special Function Registers:

View	Project	Debugger	Progr	
Pro	oject			
Ou	tput			
To	olbars		•	
CP	U Register	'5		
Ca	l Stack			
Dis	assembly	Listing		
EE	PROM			
File	e Register:	5		
Fla	Flash Data			
Ha	Hardware Stack			
LCD Pixel				
Loc	als			
Me	mory			
Pro	ogram Men	nory		
SFI	R / Periph	erals		
Spe	ecial Funct	tion Register	'S	
Wa	atch			
1 N	1emory Us	age Gauge		
Sim	nulator Tra	ice		
Sim	nulator Log	gic Analyzer		

Special Function Registers				
Address	SFR Name	$\nabla$	Hex	<b>▲</b>
	TMR3_Prescale		0x00	
FFD	TOS	:	000000x0	
FFE	TOSH		0x00	
FFD	TOSL		0x00	
FFF	TOSU		0x00	
F92	TRISA		0x7F	
F93	TRISB		OxFF	
F94	TRISC		OxFF	
F95	TRISD		OxFF	
F96	TRISE		0x07	
F40	TXBOCON	0x00		
F46	TXBODO	0x00		
F47	TXBOD1	0x00		
F48	TXBOD2		0x00	
F49	TXBOD3		0x00	
F4A	TXBOD4		0x00	
F4B	TXBOD5		0x00	
F4C	TXBOD6		0x00	
F4D	TXBOD7		0x00	
F45	TXBODLC		0x00	•

Special Function Registers window will appear:

Click on **SFR Name** column to sort by SFR name. Scroll to TRISC. The value of TRISC is now FF hex. This is the default value upon reset.

Press F7 to step one more instruction. This will cause the instruction

#### movwf TRISC

to execute and this instruction will assign the value of W ( Accumulator ) to TRISC. Since W was assigned a value of b'11111110' ( FE hex ), TRISC will now have this value. The new value of TRISC is updated and shown in the Special Function Registers window:

Special Function Registers				
Address	SFR Name	$\nabla$	Hex	<u> </u>
	TMR3_Prescale		0x00	
FFD	TOS	-	0000000x0	
FFE	TOSH		0x00	
FFD	TOSL		0x00	
FFF	TOSU		0x00	
F92	TRISA		Ox7F	
F93	TRISB		OxFF	
F94	TRISC		OxFE	
F95	TRISD		OxFF	
F96	TRISE		0x07	
F40	TXBOCON		0x00	
F46	TXBODO		0x00	
F47	TXBOD1		0x00	
F48	TXBOD2		0x00	
F49	TXBOD3		0x00	
F4A	TXBOD4		0x00	
F4B	TXBOD5		0x00	
F4C	TXBOD6		0x00	
F4D	TXBOD7		0x00	
F45	TXBODLC		0x00	•

Another convenient method of watching variables and special function registers is to use the Watch window. Select View->Watch:

View	Project	Debugger	Prog
Pro	iject		
Ou	tput		
Тос	olbars		•
CPI	U Register	15	
Cal	l Stack		
Dis	assembly	Listing	
EEF	PROM		
File	Register:	s	
Fla	sh Data		
Har	rdware St	ack	
LCI	) Pixel		
Loc	als		
Me	mory		
Pro	gram Men	nory	
SFR	२ / Periphi	erals	
Spe	ecial Funct	tion Register	s
Wa	itch		
1 M	lemory Us	age Gauge	
Sim	ulator Tra	ace	
Sim	ulator Log	gic Analyzer	

This will open Watch window. Select the Special Function Register to be watched from the left pull down list. In this case, we are using PORTC in our program so we can watch the value of PORTC:

Watch			
Add SFR ADCON	💽 🔽 🔤 Add Syml	ol BOR_OFF_2L	-
Upda PIR3 PLUSW PLUSW PORTA PORTA PORTB PORTD PORTD PORTD POSTDF	0 1 2 5 5 5 5 5 5 5 5 5 5 5 5 5	atch 4	Value

After selecting PORTC, click the Add SFR button. PORTC will be added to the list of variables to be watched and its current value will be displayed:

Watch			
Add SER PORTC	<ul> <li>Add Symbo</li> </ul>	I_BOR_OFF_2L	•
Update	Address	Symbol Name	Value
	F82	PORTC	0x00
Watch 1 Watch	2 Watch 3 Watc	ch 4	

Press F7 twice to single step over the lines:

```
movlw b'11111110'
movwf PORTC
```

The value of PORTC will change from to FE hex:

Watch			
Add SER ADCONO  Add Symbol BOR_OFF_2L			•
Update	Address	Symbol Name	Value
	F82	PORTC	OxFE
Watch 1 Watch	2 Watch 3 Watc	sh 4	

# MicroTRAK/P18 Complete Carrier Board

### Overview

MicroTRAK/P18 Complete includes MicroTRAK Carrier Board, MINI-MAX/P18 Microcontroller Board, TB-1 Training Board, PROTO-1 Prototyping Board, I/O Module for PIC®, LCD242 LCD, KP1-4X4 Keypad, Cables, Adapter, Training Manuals, Labbook, Micro-IDE, example projects, MPLAB with Assembler, Debugger and Simulator (free download from Microchip®), Serial downloader.



#### MicroTRAK carrier board has the following configuration:

- Sockets for a microcontroller board
- Sockets for dual peripheral boards
- Keypad interface
- Industry-standard display interface for alphanumeric LCD and VFD displays.
- Connectors and cables for connection to a standard breadboard
- Expansion port for a microcontroller-specific pluggable I/O module with port connectors, port indicator LED's and port control DIP Switches.
- Configuration of the high speed input via 3 jumpers.
- Single operating unregulated voltage 6 ... 12VDC
- On-board 5 Volt regulator
- Dimensions are 8.8 X 6.7 inches (22.4 X 17.0 centimeters).
- Mounting holes of 0.15 inches (3.8 millimeters) are on four corners.
- 0° 70° C operating, -40° +85° C storage temperature range.

# I/O Module

### Overview

I/O Module is a highly useful part of MicroTRAK training kit system for use with MINI-MAX/P18 Single Board Computers (SBC). MicroTRAK is the ultimate training kit and project development platform with microcontrollers.

I/O Module allows access to all input/output (I/O) ports of the PIC18F458 micro-controller on the MicroTRAK development platform. I/O Module has 32 switches to control the PIC18F458 microcontroller inputs and 32 LED's to indicate the port statuses as logic LOW or logic HIGH.

I/O Module is powered from a 5 Volt regulated DC power source through the 36-pin input/output connector.



### I/O Module has the following configuration:

- . 36-pin pluggable module connector
- Two 32-pin expansion connector footprints (for soldering of wires or connectors by the user)
- 32 DIP switches to control the PIC18F458 micro-controller inputs
- . 32 port indicator LED's with 74ALS05 hex inverters as drivers
- Requires regulated 5VDC supply at 250mA maximum current ( when all LED's are on )
- Dimensions are 5.95 X 1.975 inches (15.1 X 5.0 centimeters).
- . Mounting holes of 0.15 inches (3.8 millimeters) are on four corners.
- 0° 70° C operating, -40° +85° C storage temperature range.

# MINI-MAX/P18 Micro-controller Board

### Overview

MINI-MAX/P18 is a general purpose, low-cost, highly reliable, and highly expandable micro-controller system. It is based on the Microchip Technology PIC18F458 single-chip Flash micro-controller. This microcontroller features

- 32K In-System Re-programmable Downloadable Flash Memory
- 1.5K RAM
- 256 bytes of EEPROM data memory
- 15 Interrupt Sources
- Two 8-bit Timers / counters with prescalers
- One 16-bit timer / counter
- Two 16-bit compare / capture PWM modules
- 10-bit 8-channel ADC
- Two analog comparators
- Programmable UART Serial Channel
- SPI and Master I2C Serial Interfaces
- Controller Area Network (CAN) Bus
- Programmable Watchdog Timer
- Brown-out detector
- 33 general purpose I/O pins

MINI-MAX/P18 board complements these features by providing

- 512-byte EEPROM (optional 128-Kilobyte EEPROM)
- RS232 Serial Port
- In-circuit Programming of the micro-controller through the serial port
- Precision reference voltage source for ADC
- Keypad connector
- LCD connector (with programmable contrast adjustment for LCD)
- Expansion bus interface to low-cost peripheral boards.

MINI-MAX/P18 board also supports PIC16F877A, PIC18F442 and PIC18F452 micro. These devices are pin compatible with the PIC18F458 and can be directly placed into the MINI-MAX/P18 PLCC-44 socket.

#### MINI-MAX/P18 is a highly reliable system:

- 2-layer Printed Circuit Board
- Hardware Watchdog timer of PIC18F458 provides protection against software failures and lock-ups.
- PIC16F648 In-System programmer supports Software Watch-Dog timer. Timeout is selectable from 1 to 127 seconds. If this function is activated, the PIC18F458 should communicate with PIC16F648 through I2C bus to prevent RESTART. When PIC18F458 fails to communicate with PIC16F648, the PIC16F648 will generate a RESET signal for PIC18F458.
- PIC16F648 generates reliable RESET signal in power-up and in brownout.

# **Specifications**

Dimensions are 2.35 X 2.40 inches (5.97 X 6.10 centimeters). Mounting holes of 0.125 inches (3 millimeters) on four corners.  $0^{\circ}$  -  $70^{\circ}$  C operating,  $-40^{\circ}$  -  $+85^{\circ}$  C storage temperature range.

### **Functional Blocks**

Figure 1 shows block diagram of the MINI-MAX/P18 system



#### Micro-controller

MINI-MAX/P18 has a Microchip PIC18F458 micro-controller (U2). Micro-controller ports and power lines are provided on a 20-pin Expansion bus (J4) for interfacing to peripherals and other external circuits. PIC18F458 has five ports: 6-bit PORTA, 8-bit PORTB, 8-bit PORTC, 8-bit PORTD and 3-bit PORTE. All of these port pins can be used as general I/O.

Four PORTB lines and three PORTE lines are available on the LCD connector. PORTE lines can be used as analog inputs. Some of PORTA, PORTB and POTRC lines are available on the Expansion connector for general I/O or have special alignments such as asynchronous serial port, interrupt inputs, A/D inputs, and timer inputs. PORTD is available on the keypad connector.

MINI-MAX/P18 has Pulse Width Modulation (PWM) circuit, which can vary LCD contrast. Alternatively it can be used as a low speed analog output.

More information on the PIC18F458 micro-controller can be obtained from Microchip's web site at <u>www.microchip.com</u>.

#### Using the Analog to Digital converter

PIC18F458 has an 8-channel 10-bit analog to digital converter. It can use on-board +5V power (Vcc) as reference voltage. For best accuracy and noise performance, ADC can be configured to use external reference that is provided on the MINI-MAX/P18 board. It is permanently connected to RA3. Also, for this purpose MINI-MAX/P18 board has separate ground circuit for analog signals. This circuit is RA2 (pin #7 on expansion connector). JP3 jumper should be set to use RA2 as the analog ground. MINI-MAX/P18 board comes with JP3 jumper, already installed at the factory.

#### **EEPROM**

MINI-MAX/P18 uses a 24C04 (U5) 512-byte Electrically Erasable Programmable Read-Only-Memory (EEPROM). Typically this EEPROM is used for storing calibration values for sensors, customer identification, serial number and other parameters. This EEPROM is on a socket and can easily be replaced with higher capacity EEPROM's (up to 128 Kilobytes).

#### In-System Programming

PIC18F458 micro-controller can be re-programmed remotely over the RS-232 interface using a second micro-controller on the board (PIC16F648). The in-circuit programming feature simplifies program development on the board since downloading programs from a host PC takes only few seconds.

<u>MC Development System</u> based on <u>Micro-IDE</u> Integrated Development Environment from BiPOM Electronics fully supports in-system programming on the MINI-MAX/P18 board using the serial port. A Windows-based program <u>WinLoad</u> from BiPOM Electronics is provided to download programs to the MINI-MAX/P18 board.

Also, BiPOM Electronics provides a special piggyback module called <u>PIGGY</u>. Using this module, the user can connect the Microchip MPLAB-ICD to MINI-MAX/P18.

Microchip's In-Circuit Debugger, MPLAB-ICD, is a powerful, low-cost development and evaluation kit for the FLASH PIC16F87XA microcontroller (MCU) family. MPLAB ICD utilizes the In-Circuit Debugging capability of the PIC16F87XA. This feature, along with Microchip's In-Circuit Serial Programming<sup>™</sup> (ICSP<sup>™</sup>) protocol, offers cost-effective in-circuit FLASH programming and debugging from the graphical user interface of the MPLAB Integrated Development Environment (IDE). A designer can develop and debug source code by watching variables, setting break points, and single-stepping. Contact Microchip Technology's Web site at www.microchip.com for information on how to use the MPLAB ICD.

#### Keypad connector

8 pins of PORTD are connected to the Keypad connector. Many different keypads (for example, 3 by 5 or 4 by 4) can be connected directly to the keypad connector. 5 Volt and Ground power lines are also available on the Keypad connector. This connector can also be used as a general-purpose port.

Reypau Connector (31)			
Signal	Pin		
RD0	1		
RD1	2		
RD2	3		
RD3	4		
RD4	5		
RD5	6		
RD6	7		
RD7	8		
Ground	9		
Vcc	10		

#### Keypad Connector (J1)

#### Table 1.

#### LCD Connector

This connector is intended for various types of alphanumeric LCD modules. RB0, RB1, RB2, RB4 are the 4-bit data bus, RE0, RE1, RE2 are the control signals. All these lines can be used as general purpose I/O. RE0-RE2 can serve as analog inputs. Vee is a slow analog PWM output to adjust contrast of LCD display. Alternatively, it can be used as a general-purpose analog output.

LCD Connector (J3)					
Signal	Pin	Pin	Signal		
Ground	1	2	Vcc		
Vee	3	4	RE2		
RE0	5	6	RE1		
N/C	7	8	N/C		
N/C	9	10	N/C		
RB0	11	12	RB1		
RB2	13	14	RB4		

#### Table 2.

#### Power Supply Unit

MINI-MAX/P18 series boards come with a 6 Volt unregulated DC power supply. Other power supplies can also be used although this invalidates the warranty. External power supply should be able to supply 6 to 12 Volts DC at minimum 100mA current. The inner pin of the power supply connector is positive and the outer ring is negative.

**WARNING:** Correct polarity should be observed when applying external DC supply to Power terminal; otherwise MINI-MAX/P18 will be permanently damaged.

MINI-MAX/P18 has an on-board 5 Volt regulator (U3).

**CAUTION:** Depending on the current requirements of the any external circuitry such as peripheral boards that are attached to MINI-MAX/P18 and the level of input voltage applied, the power regulator U3 may dissipate enough heat to cause skin injury upon touch. Contact with this regulator should be avoided at all times, even after the power to circuit has been switched off.

#### Asynchronous Serial Port

One asynchronous RS232 serial port (J2) is available on MINI-MAX/P18.

U1 converts micro-controller's RXD and TXD pins to/from RS232 levels. U1 has built-in voltage-doubler and inverter that generates +/- 10 Volts for RS232 logic levels. RS232 port is made available on a 9-pin male D connector J2. Hand-held terminals, computers, modems and other serial devices may be connected to the RS232 port. CTS/RTS Modem control lines are provided on the RS232 port. CTS is used by external host such as a PC to put MINI-MAX/P18 in program or run modes. Therefore, user applications must not use CTS line.

Signal	Pin
Not Connected	1
Receive (RXD)	2
Transmit (TXD)	3
Not Connected	4
Ground	5
Not Connected	6
RTS	7
CTS	8
Not Connected	9

#### RS232 Serial Port (J2)

Table 3

Many users try to use HyperTerminal to send some data bytes to a MINI-MAX/P18 board. HyperTerminal forces a board to PROGRAM MODE by RTS line. PIC programs can not be executed if HyperTerminal occupies the RS-232 port. We advise to use Micro-IDE terminal window instead of HyperTerminal.

#### Expansion

Most of the micro-controller pins and the 5-Volt power supply lines are available on the 20-pin MINI-MAX/P18 Expansion connector (J4) for interfacing to external circuitry, prototyping boards and peripheral boards. MINI-MAX/P18 peripheral boards can be connected either as a piggyback daughter-board on MINI-MAX/P18 using standoffs or can be placed up away from MINI-MAX/P18 using a 20-wire ribbon cable. Peripherals section lists the available expansion boards. Table 4 shows the pin assignments for the MINI-MAX/P18 Expansion connector.

Signal	Pin	Pin	Signal
RC7	20	19	RC6
RB6	18	17	RB3
RC1	16	15	RA4
RC0	14	13	RA5
RB7	12	11	RC2
RA0	10	9	RA1
RC5	8	7	RA2
RC3	6	5	RC4
VCC	4	3	GND
VCC	2	1	GND

#### MINI-MAX/P18 Expansion (J4)

Table 4

## Peripherals

MINI-MAX/P18 can be connected to a wide variety of low-cost peripheral boards to enhance its functionality. Some possibilities are:

- Prototyping board (PROTO-1)
- Training Board (TB-1)
- 4-digit 7-segment LED display board
- 12-bit Analog-To-Digital Converter Board
- Digital Input/Output Expander Board
- Real time clock + 128 MB flash card board
- Terminal board
- Reed relay board with 4 relays
- Power relay board with 2 relay
- Stepper motor driver board

Peripheral boards can either be stacked on top of MINI-MAX/P18 using stand-offs or connected in a chain configuration using flat ribbon cable. Figure 2 shows how MINI-MAX/P18 can be connected to a peripheral board in a stacked fashion. Figure 3 shows chain connection.







Figure 3

More details concernig BiPOM Peripheral boards are available from the link below:

www.bipom.com/peripherals.php

#### RS232 Devices

Various keypads and terminals may be connected to the RS232 port of MINI-MAX/P18 through connector J2. MINI-MAX/P18 can be connected to a host PC through the RS232 port. For example, MINI-MAX/P18 can be used as a remote data acquisition or control unit serving a host PC in a client-server configuration.

Connection to a host PC is accomplished by using a NULL-Modem cable. MINI-MAX/P18 end of this cable should be a 9-pin Female D connector for connection to J2 on the MINI-MAX/P18 board. Host PC end of this cable can be either 9-pin Female or 25-pin Female D Connector depending on available serial (COM) ports on the host PC.

MINI-MAX/P18 board comes with a NULL modem (LapLink) cable that has the following wiring connections:

MINI-MAX/P18	9-pin			Host PC 9-pin Female	
Female					
RECEIVE DATA (RXD)		2	3	TRANSMIT DATA (TXD)	
TRANSMIT DATA (TXD)		3	2	RECEIVE DATA (RXD)	
GROUND		5	5	GROUND	
RTS		7	8	CTS	
CTS		8	7	RTS	

MINI-MAX/P18 9-pin Female			Host PC 25-pin Female	
RECEIVE DATA (RXD)		2	TRANSMIT DATA (TXD)	
TRANSMIT DATA (TXD)	3	3	RECEIVE DATA (RXD)	
GROUND	5	7	GROUND	
RTS	7	5	CTS	
CTS	8	4	RTS	

Table 5

# Software

MPASM development system provides a lot of examples for the MINI-MAX/P18 board to access onboard peripherals and perform self-diagnostics.

Please download the development system from <u>www.bipom.com/mmpicsoft.php</u> Also, WinLoad Windows Loader is available to download program codes to the MINI-MAX/P18:

# **Board Layout**



# **Schematics**



# **TB-1 TRAINING BOARD**

### Overview

Training Board TB-1 allows performing various experiments with most microcontrollers. TB-1 features:

- 3 Traffic light LED's (red, yellow, green)
- 2 interrupt inputs
- 2 switch inputs ( in parallel with interrupt inputs )
- 2 timer/counter inputs
- 4 channels of 8-bit analog inputs
- Programmable buzzer
- Expansion bus to other boards

#### TB-1 is already connected to the MINI-MAX/P18 board as part of the MicroTRAK.

### **Specifications**

Dimensions are 2.35 X 2.40 inches (  $5.97 \times 6.10$  centimeters ). Mounting holes of 0.125 inches ( 3 millimeters ) on four corners. 0° - 70° C operating, -40° - +85° C storage temperature range

### **Board Layout**

Layout of TB-1 board is shown below:



### **Functional Blocks**

#### **Expansion**

TB-1 is connected to MINI-MAX/P18 and other boards through the Expansion Connector (J1). Table 4 shows the pin assignments for the Expansion Connector.

Signal	Pin	Pin	Signal
P3.0	20	19	P3.1
P3.2	18	17	P3.3
P3.4	16	15	P3.5
P3.6	14	13	P3.7
P1.0	12	11	P1.1
P1.2	10	9	P1.3
P1.4	8	7	P1.5
P1.6	6	5	P1.7
VCC	4	3	GND
VCC	2	1	GND

#### Expansion (J1)

#### Table 4

#### LED's

TB-1 has 3 Light Emitting Diodes (LED's) that are connected in a traffic light pattern. Red and green LED's are on each side and the yellow LED is in the middle.

LED's are driven by a 7407 buffer (IC2). Each LED has two pins; cathode (negative terminal) and anode (positive terminal). The current through the LED's are limited through current limiting resistors that tie the anode pins to Vcc. To turn an LED on, the cathode is pulled to ground through the corresponding gate of the 7407 buffer. To turn an LED off, the corresponding gate of the 7407 buffer is deactivated by setting the input of the gate to a logic high level.

#### <u>Buzzer</u>

Because the buzzer requires higher current than the LED's, buzzer is driven by three 7407 buffer gates that are connected in parallel. Due of the inductive nature of the buzzer, a freewheeling diode (D4) is used to clamp reverse voltages that may be induced on the buzzer when the buzzer is being turned on or off.

#### **Buttons**

There are 2 push buttons on the TB-1. Each button is connected through a protection resistor to an interrupt input (P3.2 and P3.3) on the micro-controller. Pressing a button forces a logic low level on the corresponding micro-controller input.

#### Interrupt Inputs

Port pins P3.2 and P3.3 can be used either as general-purpose inputs/output or as interrupt inputs. A high to low logic transition or a low logic level on those inputs can cause a hardware interrupt to be generated.

#### Timer/Counter Inputs

Port pins P3.4 and P3.5 can be used either as general-purpose inputs/output or as timer/counter inputs. Logic level changes on these inputs can be counted by the timer hardware on the micro-controller eliminating the need for software polling loops.

#### Analog/Digital Converter (ADC)

TB-1 has a type ADC0834, 4-channel, 8-bit Analog/Digital converter. Analog inputs are available on X1 terminal block. Analog/Digital Converter is controlled by the micro-controller through 4 port lines. Chip Select (CS) is an input to the ADC. Chip Select enables data conversion when it is logic low and disables data conversion when it is logic high. Clock is an input to the ADC. Mode of operation (single-ended versus differential) and channel number is entered through the DI pin one bit at a time (on every transition of the Clock input). The 8-bit data that corresponds to the voltage on the selected channel is output on DO one bit at a time (on every transition of the Clock input).

## **TB-1 Schematics**



### **Advanced Project Ideas**

- Using the MicroTRAK as a frequency counter: Student develops a PIC® program to measure the frequency and/or period of an incoming signal using PIC18F458's interrupt inputs. The results are then displayed on the terminal window. Input signal is provided from a lab signal generator.
- Using the MicroTRAK as a temperature controller: Student develops a PIC® program to connect LM35 or similar temperature sensor to the analog inputs. Depending on the temperature reading one of red, yellow or green LED's are illuminated. If the temperature goes above a preset threshold, the buzzer sounds.
- Using the MicroTRAK EEPROM and the Analog-To-Digital Converter as a multi-channel data logger.