

anidea engineering, inc

AEI 2000

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Features

Processor

- Freescale 40MHz HCS08GB60
- 60K Flash, 4K RAM
- 3 & 5 Channel Timers
- 8-channel, 10-bit ADC
- 2 UARTS
- SPI & I2C
- Background Debugging System

Real Time Clock

- Intersil ISL12029
- Battery Backup
- System Reset
- External Watchdog

AC Control

- 25A, 600VAC Triac
- Zero Cross Detection
- Optically Isolated

Thermocouple Input

- Precision, High Gain Analog Input for High Temperature Reading

Temperature Sensor

- On board NTC for On Board Temperature Reference

Power Relay

- SPST Contact Rated for 10A @ 250VAC

PWM Driver

- 3 PWM channels with Low Side Drivers
- 4A Sink FETs
- Back EMF Protection Diodes (drive inductive loads directly)

User Interface

- 2 x 20 Character LCD Screen
- White LED Backlit LCD
- 4 Navigation Buttons
- 3 Status LEDs
- 3 Diagnostic LEDs
- Auto Contrast
- Integrated on a Mounting Plate or Custom Design

Motor Driver

- Allegro A3995
- Dual 2.4A Current Regulated Motor Driver
- Synchronous Rectification
- Limit Switch Inputs

DMX / RS-485

- Isolated Interface
- Networkable
- DMX Pass-thru
- DMX Remote Control Power Relay
- Terminal Block for RS-485

Expansion Port

- 24 Pin Expansion Port with Timer, UART, SPI, I2C, ADC, and GPIO pins available

Power

- 8-28VDC Input
- 50ma Idle
- Local 5V and 3.3V Supplies

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PROPRIETARY MATERIAL!

The design of the AEI 2000 is wholly owned by Anidea Engineering, Inc. and is its proprietary property. This design shall not be copied in whole or in part without the express written consent of Anidea Engineering, Inc. If you would like your own special version of this or any other design, please contact us and we'll be happy to provide design services or design licensing.

WARNINGS!

This document is to be used by qualified professionals who are familiar with high voltage AC mains (wall power).

Some versions (AC Module) of this system operate in an environment that includes dangerous voltages. When operating from an ac line, controller portions, power stage grounds, and oscilloscope grounds are at different potentials, unless the oscilloscope is floating. Note that probe grounds and therefore, the case of a floated oscilloscope, are subjected to dangerous voltages.

The user should be aware that:

- Before moving scope probes, making connections, etc., it is generally advisable to power down all power supplies.
- When high voltage is applied, using only one hand for operating the test setup minimizes the possibility of electrical shock.
- Operation in lab setups that have grounded tables and/or chairs should be avoided.
- Wearing safety glasses, avoiding jewelry, using shields, and operation by personnel trained in high-voltage lab techniques are also advisable.

Conventions

Physically processor pins are labeled by the name Freescale uses, such as "PTA0". When followed by a set of parentheses "()", the name inside is the net name on the AEI2000 schematic.

Components on the board are linked to their datasheets. Components the user may want to procure, are linked to buy pages on Digi-Key's (or other vendor's) website.

System Overview

The AEI 2000 is a very versatile system controller with many peripherals for a wide range of applications from heaters, lighting, temperature sensing, industrial control and much more. A 2 x 20 LCD screen, buttons, and LEDs provide a flexible user interface for a wide range of applications.

Build Configurations

A controller is available in two standard build configurations. The standard configuration is a fully loaded controller with optional 5-Pin XLR connectors for full DMX functionality. There is also an AEI 2000L which reduces the functionality to a general controller board. The AC Control, Thermocouple, and Motor Driver modules are removed. The isolation of the DMX / RS-485 is also removed. The DMX option is available in this configuration.

Table 1: Build Variations

Orderable Part Number	Options								Target Market
	User Interface	AC Control	Thermocouple	Motor Driver	DMX / RS-485	DMX Isolation	XLR Conn	Power Relay	
AEI2000-DMX	•	•	•	•	•	•	•		Professional Theatrical Equipment
AEI2000L	•			•	•				Versatile General Controller
AEI2000L-B				•	•				Embedded Systems
AEI2000L-DMX	•			•	•		•		Low to Mid Level Theatrical Equipment
AEI2000	•	•	•	•	•	•			Versatile General Controller
AEI2000-B		•	•	•	•	•			Embedded Systems

Development Kits

Development kits are available on from our website and include everything you need to fully evaluate the AEI2000. Student discounts are available.

Design Flexibility

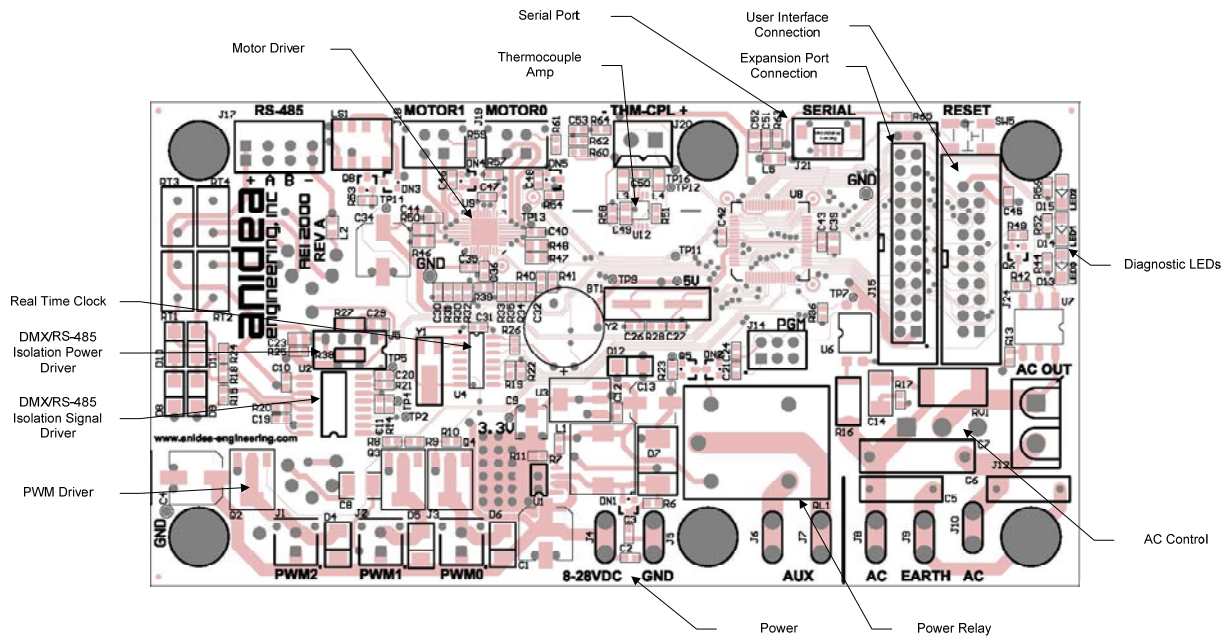
The AEI 2000 was designed to be mounted on a single aluminum plate to form an easily mountable module for many applications. However, if needed, the User Interface can be separated from the main board and extended by the use of ribbon cables.

Additionally, the availability of an expansion port allow for many other peripherals to be added on for special purposes such as serial level translators, large flash devices, high resolution ADCs, special drivers, and much more.

Peripherals

The AEI 2000 integrates a wide variety of peripherals for many applications. Not all build configurations have every peripherals populated. Please check the your board to determined which

The following tables illustrate key components, locations and processor interface of the AEI 2000 Peripherals.



User Interface

The AEI 2000 User Interface consists of a 2 x 20 LCD Chip-on-Glass LCD Screen, 4 tact buttons, and 3 LEDs (green, yellow, and red).

The screen is white LED backlit.

While it is up to the end developer to assign specific functionality to the User Interface LEDs and buttons, the designed functions are Back, Up, Down, and Enter for the buttons and Power, DMX Activity, and Error for the LEDs.

The AEI2000 is typically provided with a blank aluminum plate which all of the PCBs are mounted to. A digital Lexan label can be created from [Maverick Label](#) very cost effectively. Anidea Engineering can provide templates for the label and the aluminum plate if requested.

Table 2: User Interface Processor Connections

Peripheral	Key Component	Location	Processor Pin
Buttons	KSC241J	SW1 (Enter)	PTA0 (KEY0)
		SW2 (Down)	PTA1 (KEY1)
		SW3 (Up)	PTA2 (KEY2)
		SW4 (Back)	PTA3 (KEY3)
User LED - Green	CML CMD95-21VGC	D3 (Power)	PTF0 (POWER_LED)
User LED - Yellow	CML CMD95-21VYC	D2 (Activity)	PTF1 (ACT_LED)
User LED - Red	CML CMD95-21VRC	D1 (Error)	PTF2 (ERR_LED)
Back Light	Fairchild Semiconductor NDS355AN	Q1	PTD1
Diagnostic LED 0	BR1101W	D13	PTF5
Diagnostic LED 1	BR1101W	D14	PTF6
Diagnostic LED 2	BR1101W	D15	PTF7
LCD	New Haven Technologies NHD-C0220AU-FSW-FTS	LCD1	PTG3 (Data 4) PTG4 (Data 5) PTG5 (Data 6) PTG6 (Data 7) PTG7 (Enable) PTB2 (RWn) PTB3 (RS)

Real Time Clock

The real time clock utilizes an Intersil ISL12029. The device also supports reset, watch dog, and non-volatile memory. It is powered by a BR1225 Lithium battery.

Table 3: Real Time Clock Processor Connections

Peripheral	Key Component	Location	Processor Pin
RTC	Intersil ISL12029	U4	PTC2 (SCL) PTC3 (SDA) PTA4 (SQR_INT)

Thermocouple and Temperature Sensors

The temperature measurement system consists of a NTC device for local temperature sensing and a high gain op-amp for amplifying the signal from the thermocouple.

The NTC is a 10K device (@25C) with a 10K pullup. A .01uf filtering capacitor is across the input for noise filtering.

A Texas Instruments INA326 is used for this purpose. For proper thermocouple operation, the thermocouple must either be floating or very close to the same potential as the DC ground of the board. Please refer to the INA326 datasheet for common mode input range specifications. The gain of the amplifier is 200. The amplifier is in a singled ended configuration. Temperature measurements via the thermocouple are

limited to temperatures above or below ambient depending on how the thermocouple is wired.

Table 4: Thermocouple and Temperature Sensor Processor Connections

Peripheral	Key Component	Location	Processor Pin
NTC Thermister	Murata NCP18XH103J03RB	R62	PTB0 (TEMP)
Amplifier	Texas Instruments INA326	U12	PTB1 (COLD_TEMP)

Table 5: Thermocouple Board Connections

Connection	Location	Function	Connectors
Thermocouple Input	J20	1 - Positive	Board – Phoenix Contact 1803426
		2 – Negative	Mate – Phoenix Contact 1803578

Motor Driver

The Motor Driver implements an Allegro A3995 which has dual current regulated 2.4A outputs with synchronous rectification. Decay modes, direction, breaking, and enable (PWM) are software controllable. The current regulation is factory set at .5A per motor. This can be modified by the user by selecting different sense resistors (R46, R47, R48, R50) or modifying the reference network (R30 – R35, R39). Please refer to the datasheet for details. The device is powered by the main power rail supplied at J4. Utilizing the current regulation provides a very flexible system design to function with many motors.

The Motor Limit Inputs are a set of protected inputs which can be used to sense a limit switch or other general purpose input. They are isolated from the processor by a 100 ohm series resistor, a diode network and filtering cap.

Table 6: Motor Driver Processor Connections

Peripheral	Key Component	Location	Processor Pin
Motor Limits	N/A	N/A	PTA6 (MOTOR0_LIMIT0n) PTA7 (MOTOR0_LIMIT1n)
Motor Driver	Allegro A3995	U9	PTF3 (MOTOR0_DIR) PTF4 (MOTOR1_DIR) PTE6 (MOTOR0_MODE) PTE7 (MOTOR1_MODE) PTD6 (MOTOR0_PWM) PTD7 (MOTOR1_PWM)

Table 7: Motor Driver Connections

Connection	Location	Function	Connectors
Motor Limit 0 Motor Limit 1	J19 J18	1 – Motor A	Board – Molex 43045-0412
		2 – Motor B	Mate – Molex 43025-0400
		3 – Motor Limit X	Contact – Molex 43030-0007
		4 – DC Ground	

PWM Driver

The PWM Driver contains 3 power FETs each connected to a PWM output of the processor. The FETs have the ability to sink 4A each. Please power handing for you application. Each FET is also protected with a back EMF diode (MBRS1100).

Table 8: PWM Driver Processor Connections

Peripheral	Key Component	Location	Processor Pin
FET Driver	Fairchild Semiconductor NDT3055L	Q4 Q3 Q2	PTD3 (PWM0) PTD4 (PWM1) PTD5 (PWM2)

Table 9: PWM Driver Board Connections

Connection	Location	Function	Connectors
PWM0 PWM1 PWM2	J3 J2 J1	1 – Positive Rail	Board – Molex 43045-0212
		2 – Negative, Switched	Mate – Molex 43025-0200
			Contact – Molex 43030-0007

DMX / RS-485

The DMX / RS-485 module is a very flexible and powerful interface. DMX-512 functionality provides the ability to integrate into the standard interface used by stage and lighting professionals. DMX is used by simple lights, automated lightings, fog machines and may more types of devices. DMX is based on RS-485. RS-485 connectivity facilities flexible communication to PCs, industrial I/O points, and much more. The module supports bidirectional data rates at 250kbps (DMX standard) and up to 5Mbps.

The module is protected behind 400Wpk Zener diodes and PTC devices.

The DMX portion of the interface provides two Neutrik 5 pin XLR connectors in a pass thru configuration. Additionally, to support tethered remote control functionality, a relay can be activated to place 5V on the unused pins 4 and 5 in the DMX standard. This allows remote control devices to be powered.

Furthermore, a newer protocol which extends DMX is RDM (remote device management). The bidirectional capability of the AEI2000 facilitates full RDM capability. Please visit [ESTA](#) for DMX and RDM standards information.

RS-485 termination and fail-safe modes are not populated, but provisions are located at R15, R18, and R24. To terminate the RS-485 network (also for source nodes of DMX), place a 121 ohm resistor at R18. Additionally, if fail-safe (RS-485 biasing) is desired, place 510 ohm resistors at R15 and R24. For volume orders, these parts can be placed at no charge.

The module also provides galvanic isolation from the rest of the system. This is useful in theater and industrial environments where grounds can float and be problematic. For volume orders, these additional parts can be removed to save costs. Please consult Anidea Engineering, Inc. for further information.

Table 10: DMX / RS-485 Processor Connections

Peripheral	Key Component	Location	Processor Pin
RS-485 Transceiver	NVE IL3285	U2	PTC3 (RS485_TX) PTC4 (RS485_RX) PTC4 (RS485_TX_EN)
Remote Power	Omron G6K-2G-Y-DC5	LS1	PTC5 (REMOTE_PWR_EN)
Power Isolation	CUI VBSD1-S5-S5-DIP	U5	N/A

Table 11: DMX / RS-485 Board Connections

Connection	Location	Function	Connectors
RS485	J17	1 – 5V*	TBD
		2 – Data A (+)	
		3 – Data B (-)	
		4 – Ground*	
DMX In DMX Out	U14	1 – Ground*	Neutrik NC5MAV Neutrik NC5FAV
	U13	2 – Data B (-)	
		3 – Data A (+)	
		4 – Remote Ground	
		5 – Remote +5V	

*When the isolated power module is in place, these connections are NOT referenced to the system ground. A 1000pf, 1000V capacitor connects EARTH to this ground (C8).

AC Control

The AC Control module consists of two separate circuits, a zero cross detector and a random phase triac driver. The module is suitable for controlling heaters, lamps, fans, and many other loads. Each specific application should be tested. The main part of the controller is optically isolated from the AC mains.

The zero cross detector will generate a small pulse on slightly before and slightly after the zero crossing of the AC line. To implement the triac control, trigger an interrupt service routine from the leading edge of this signal.

The triac driver controls a 25A triac. A short pulse (~100us) should be generated at the time when you want triac to begin conducting. The triac will turn itself off at every zero crossing. A snubber circuit and a TVS device are located across the load for noise filtering. Additionally, 'X' and 'Y' capacitors are placed on the input AC lines to limit conducted emissions. The X cap is .1uf and the Y caps are 2200pf. Each application should be tested for compliance in accordance with local standards. Variations of these values are available in volume orders to fit specific requirements.

The entire AC Control module is optically isolated from the reset of the controller by a spacing of >.051". The module is suitable for control of the AC main line up to 240VAC, 13.5A.

Table 12: AC Control Sensor Processor Connections

Peripheral	Key Component	Location	Processor Pin
Zero Cross Detector	Fairchild Semiconductor FOD814A	R62	IRQn (ZERO_CROSSING)
Triac Driver	Fairchild Semiconductor MOC3052M	U7	PTB1 (TRIAC_DRV)
	ST Micro BTA26-600BWRG	Q9	

Table 13: AC Control Board Connections

Connection	Location	Function	Connectors
AC Power In	J8	Line 1	Board – Amp/Tyco 197054001 Mate – Amp/Tyco 3-520117-2*
	J9	Earth	
	J10	Line 2	
AC Power Out	J10	1 – Line 1	Board – Molex 10-84-4020 Mate Housing – Molex 50-84-1020 Mate Crimp – Molex 02-08-1002
		2 – Line 2	

*Application may dictate different components.

Power Relay

The Power is a simple SPST switch. The relay is rated at 250VAC at 10A.

Table 14: Power Relay Processor Connections

Peripheral	Key Component	Location	Processor Pin
Power Relay	Panasonic JS1A-5V	RL1	PTD2 (POWER_RLY_EN)

Table 15: Power Relay Board Connections

Connection	Location	Function	Connectors
Contact 1 Contact 2	J6 J7	Contacts	Board – Amp/Tyco 197054001 Mate – Amp/Tyco 3-520117-2*

*Application may dictate different components.

Serial Port

The Serial Port is a basic two line serial port interface with TTL level signals. It is suitable for communications to many types of external devices as well as debugging.

Table 16: Serial Port Processor Connections

Peripheral	Key Component	Location	Processor Pin
UART	Integrated part of processor.	N/A	PTE0 (UART_TX) PTE1 (UART_RX)

Table 17: Serial Port Board Connections

Connection	Location	Function	Connectors
Serial Port	J21	1 – UART_TX	Board – Hirose DF13B-4P-1.25V Mate Housing – Hirose DF13-4S-1.25C Mate Crimp – Hirose DF13-2630SCF
		2 – UART_RX	
		3 – GROUND	
		4 – GROUND	

Expansion Port

The Expansion Port is provided for advanced applications where other peripherals or connections need to be added to the AEI2000. All processor communication ports and a subset of other specialized ports are available here. The connector is designed in such a way to support either a polarized cable connection or a PCB daughter card.

Table 18: Expansion Port Processor Connections

Peripheral	Key Component	Location	Processor Pin
Power		J15-1	Power – +5V*
		J15-2	Ground

I2C		J15-3	PTC2 (I2C_SDA)*
		J15-4	PTC3 (I2C_SCL)*
UART		J15-5	PTE0 (UART_TX)
		J15-6	PTE1 (UART_RX)
SPI		J15-7	PTE3 (SPI_MISO)*
		J15-8	PTE4 (SPI_MOSI)*
		J15-9	PTE5 (SPI_CLK)*
		J15-10	PTE2 (SPI_SS _n)
GPIO		J15-11	PTA4 (PTA4)
		J15-12	PTA5 (PTA5)
		J15-13	PTA6 (PTA6)
		J15-14	PTA7 (PTA7)
		J15-15	PTC6 (PTC6)
		J15-16	PTC7 (PTC7)
		J15-17	PTB5 (ADC_PT _B 4)
INTERRUPT		J15-18	IRQ _n (ZERO_CROSSING)*
PWM		J15-19	PTD3 (PWM0_PTD3)*
		J15-20	PTD4 (PWM1_PTD4)*
		J15-21	PTD5 (PWM2_PTD5)*
ADC		J15-22	PTB5 (ADC_PT _B 5)
		J15-23	PTB6 (ADC_PT _A 6)
		J15-24	PTB7 (ADC_PT _A 7)

*Signal may also be used on board. Please check design for conflicts.

Table 19: Expansion Port Board Connections

Connection	Location	Function	Connectors
Expansion Port	J15	Expand utility of the core board design.	Board – Supports most .1" spaced header or connector.

Power

The power supply to the AEI 2000 is a wide input 8V to 28V. The board draw is ~50mA at 24V. The main supply feeds into a switching regulator to create a regulated 5V supply for the DMX / RS-485 Module and the relays. It also powers the 3.3V regulator. There is about 500mA of 5V power available at the Expansion Port. There is about TBD (200)mA of 3.3V power available at the Expansion Port.

Please see the Thermocouple and Temperature Sensors section for special considerations about ground isolation.

Table 20: Power Board Connections

Connection	Location	Function	Connectors
Main Board Power	J4	Power	Board – Amp/Tyco 197054001
	J5	Ground	Mate – Amp/Tyco 3-520117-2*

*Application may dictate different components.

Software Development Kit

The software development kit packaged with the AEI 2000 is from Freescale (Metrowerks) and includes a PE Micro Multilink for background debugging. Please follow the installation instructions with the kit.

Sample starter files are available for download from the website or contact support for details.

All of the on board peripherals are configured and drives for many applications are provided.

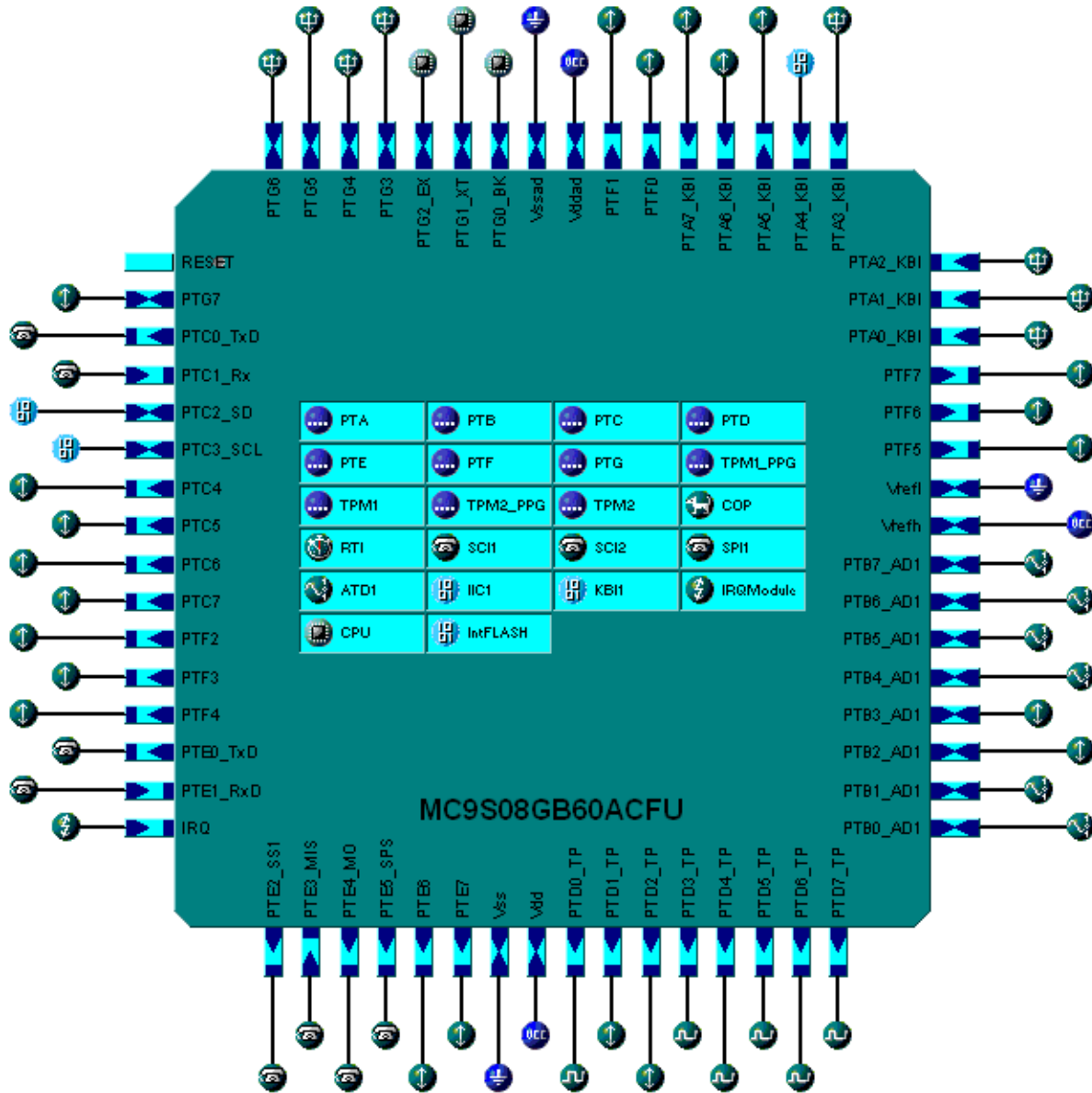
Two sample applications are also provided in the SDK.

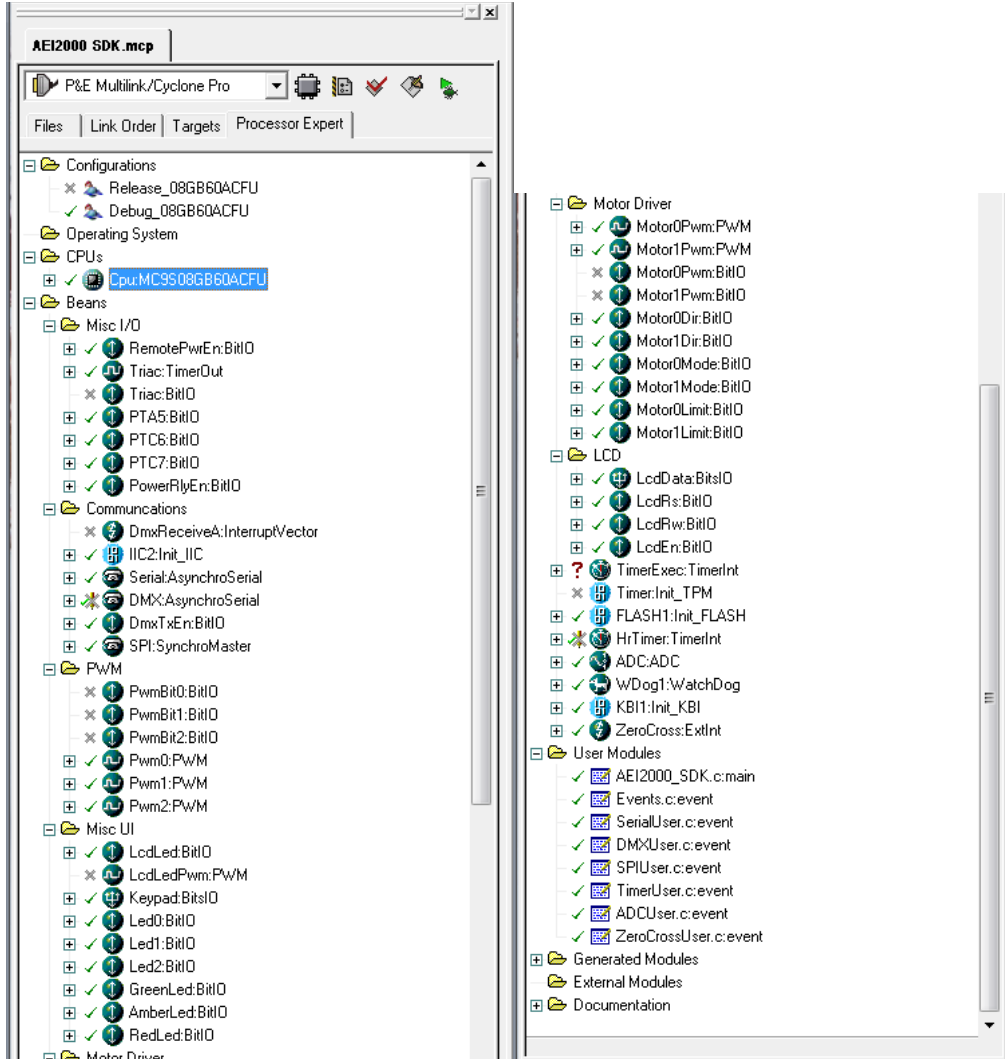
The first SDK application is a DMX receiver and transmitter system. The DMX receiver translates 7 channels of the DMX frame into motor controls, triac control and PWM control.

The second SDK application is a 4 stage toaster reflow system.

Additionally, a menu system and a general system architecture are provided for rapid application development.

Sample screen shots of the SDK:





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