PMC-Eight™ Technology: Sharing the Vision

The Philosophy Behind the Design of the PMC-Eight System and Its Functionality and How the OpenGOTO Community Will Drive Its Future Direction

Jerry Hubble, Director Electrical Engineering
Explore Scientific, LLC.

Almost Heaven Star Party, September 9, 2018
Introduction – Jerry Hubbell

• **Jerry Hubbell** is currently the Director of Electrical Engineering for Explore Scientific, LLC. and the Principle Engineer heading the team on the development of the PMC-Eight™ mount control system.

• Retired Dominion Nuclear Instrumentation and Controls Engineer with over 35 years of experience in the Nuclear and Electric Utility business.

• The Assistant Director for the Mark Slade Remote Observatory (MSRO).

• The Assistant Coordinator for Topographical Studies, Lunar Section of the Association of Lunar and Planetary Observers (ALPO).

Almost Heaven Star Party Booth - 2017
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Presentation Topics

• Explore Scientific’s Product Design Goals
• The Vision Behind the PMC-Eight™ System
• PMC-Eight™ System Design Philosophy
• PMC-Eight™ System Architecture and Design Features
• The OpenGOTO Community
Explore Scientific’s Product Design Goals

- Explore Scientific is first and foremost a customer focused business that strives to meet your needs and provide the most cost effective solutions available.

- Our goal is to provide high-performance, high-value astronomical instruments that are trouble-free and makes it easy for you to observe the sky.

- The intent is to design equipment that get’s out of your way and virtually “disappears”

- Overall, our design goal is to provide equipment that performs at >90% of best-in-class equipment at half the price.
The Vision Behind the PMC-Eight™ System

• Scott Roberts and Jerry Hubbell first developed the concept of the PMC-Eight™ mount control system in 2013. Scott’s goal was to develop a fully-documented control system that could be shared with the Explore Scientific customer in an “Open-Source” way.

• Based on his nearly 40 years of experience in the astronomical equipment business, Scott proposed that we create the OpenGOTO™ Community as a program and platform to share the system with our customers and all who are interested, and make it easy for customers to develop their own software for the PMC-Eight™ System.

• Based on his over 35 years of nuclear industry instrumentation experience, Jerry proposed a control system architecture that primarily made it as easy as possible to create applications for the hardware system, that provided the utmost flexibility in integrating new hardware features, and finally, provided as much performance margin as possible.

• The result is a product family that is designed to have a very long life-cycle and will provide opportunities for new PMC-Eight products to be developed over the next 10+ years, and be supported by Explore Scientific for > 25 years.
The Vision Behind the PMC-Eight™ System

PMC-Eight Development Timeline:

• Development Started in 2013
• PMC-Eight System Architecture Proposal March 2013
• PMC-Eight Hardware Prototype Development Started July 2013
• ExploreStars for PMC-Eight Development Started December 2013
• Jerry Hubbell Hired as Director Electrical Engineering January 2014
• Final First Release PMC-Eight Design Configuration April 2015
• First feature complete PMC-Eight Prototype August 2015
• Initial ASCOM Driver Beta Release April 2016
• FCC Testing Completed February 2017
• First G11 PMC-Eight Customer February 2017
• First EXOS 2 PMC-Eight Customer April 2017
The Vision Behind the PMC-Eight™ System
The PMC-Eight™ System Design Philosophy

- The PMC-Eight™ System has a simplified command language interpreter that makes it much easier for you to learn and start building that custom application.

- The PMC-Eight™ Command Language is “motor-centric” in that unlike all other telescope mount systems this one does not have any astronomy related commands in the language.

- This makes the controller more of an industrial strength motion control system rather than a standard hand-control based system; thus the name “Precision Motion Controller.”

- There are several advantages to this control system architecture including: simplified hardware/firmware design, and language features that are mapped directly to the ASCOM Standard Platform and provides modular software design and development.

- This simplified architecture provides reliability, performance, and ease of use all in one.
The PMC-Eight™ System Design Philosophy

- The OpenGOTO™ Community is your gateway to learning all about the PMC-Eight™ System and working with other like minded customers in developing cutting edge astronomical applications. To this end, Explore Scientific is making available user and technical documents, and is making our software open-source.

- The OpenGOTO™ Community is made up of several groups including PMC-Eight™ customers, software developers, and other interested parties that wish to not only learn all about the PMC-Eight system, but also contribute to the long-term success and viability of the PMC-Eight™ family of control systems.

- The OpenGOTO™ Community incorporates the use of several web-based social media, and collaborative platforms to facilitate the dissemination of PMC-Eight™ information.

- The OpenGOTO™ Community Steering Committee was founded in July 2018 to create the infrastructure needed by the community and to foster the further development and support of the PMC-Eight™ System.
The primary purpose of the PMC-Eight Mount Control System is to enable the user to easily navigate the sky, locate and identify various celestial objects such as double stars, nebulae, galaxies, and major and minor planets, and

• Our goal in developing the PMC-Eight is to provide our customers with a modern, state-of-the-art mount controller that is both easy to learn and use, and provides advanced features sought by those interested in doing professional level observations with their Astronomical Imaging System (AIS).

• The PMC-Eight Control System helps you learn about the sky and allows you to concentrate on observing celestial objects while the system gets out of your way and virtually disappears.

• Explore Scientific’s goal is to provide advanced astronomical instruments and equipment that are both high-performance and priced aggressively. The result of this philosophy are high-value products that give you the most “bang for the buck”.

The PMC-Eight™ System Design Philosophy
The PMC-Eight™ System Architecture

- The PMC-Eight is a revolution in telescope mount control systems. PMC stands for “Precision Motion Controller” which perfectly describes the overall design philosophy of the control system. “Eight” refers to the processing engine of the controller which has an 8 CPU multi-processor microcontroller.

- This processor allows the PMC-Eight to handle 8 separate, independent tasks while providing a shared memory space for inter-process communications.

- The system is a “precision” controller in that it can precisely set different mount control parameters and motor drive settings to dynamically manage motor drive current, rate, ramping, and positioning.

- The system design incorporates high-performance thermal, electrical, and task reliability features that guarantees reliability.
The PMC-Eight™ System Design Features

Highly Reliable – High Performance Design – Industry Firsts

- Clean Sheet Hardware/Firmware/Software Design
- Highly Reliable – High Performance Firmware Design
  - Deterministic Multi-Tasking Firmware
  - Each Main Task Executed On Dedicated Processor – 8 processors in Main CPU
  - Dedicated Wireless Communications Processor
- Highly Reliable Thermal Design – Heavy Duty Enclosure
  - Demonstrated Wide Temperature Range 0 – 100+ Degrees F
The PMC-Eight™ System Design Features

- Highly Reliable Environmental Protection
  - Moisture Resistant Conformal Coating
  - High Quality, Locking Motor Cable Connections
- First Multi-Core MicroController Mount Control System
- First Fully Integrated Wireless Communications System
- First Open-Source Code, Example Code, and Command Language Sharing
- First Wireless ASCOM Platform Compliant Driver
PMC-Eight™ Model 2A-06B Production
PMC-Eight™ Model 2A-06B Production Board
Parallax Propeller 8-processor Micro-Controller
PMC-Eight™ Control System Function Diagram
Available PMC-Eight™ Mount Systems

- The PMC-Eight™ is offered on the ES/Losmandy G11 mount and on the Explore Scientific EXOS II PMC-Eight mount.

- The PMC-Eight™ System will be available on a new mount system by the end of the year called the iEXOS 100.

- We will be announcing other new mount systems in 2019 and also the possibility of a Software Development Kit which will include the base PMC-Eight Hardware system.
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ES/Losmandy G11 PMC-Eight™ Mount
Explore Scientific EXOS II PMC-Eight™ Mount
Explore Scientific iEXOS 100 PMC-Eight™ Mount
Future Explore Scientific iEXOS 100 Controller SDK
The purpose of the OpenGOTO Community is to allow our customers and other interested parties to partner with Explore Scientific in creating the infrastructure to support and grow the PMC-Eight System.

The OpenGOTO Community consists of both infrastructure, resources and social support groups, and volunteer members who participate at whatever level they are comfortable.

Explore Scientific established the OpenGOTO Community Steering Committee (OGCSC) in July 2018 to guide the development of the community and to establish and manage the infrastructure and resources dedicated to the community.

The mission of the OGCSC is to ensure the sharing of all the PMC-Eight System documentation, source-code, and knowledge base and also to facilitate discussion between members of the community and Explore Scientific.
The OpenGOTO Community Steering Committee

- The OGCSC created the organization’s charter and approved it on September 4, 2018.
- The purpose of the OGCSC as established in the charter is:
  - To create the infrastructure necessary to implement the OpenGOTO Community and enable the community membership to enjoy the benefits of this infrastructure.
  - To facilitate the dissemination of complete and accurate information about the hardware and software for the PMC-Eight system to enable the OpenGOTO community members to maximize their use of the PMC-Eight system.
  - To maximize the support provided to PMC-Eight System customers through the community organization and infrastructure and maximize the performance of the Explore Scientific Customer Support team.
PMC-Eight™ System In Summary

• A hardware platform that is designed with reliability built in, has high performance, and provides plenty of margin for further development and has a long life-cycle

• A fully-documented control system that is shared with the Explore Scientific customer in an “Open-Source” way

• The OpenGOTO™ Community created as a program and platform to support and share the system with our customers and all who are interested, and make it easy for customers to communicate with each other and develop their own software for the PMC-Eight™ System.

• A control system architecture that makes it easy to create applications, provides the utmost flexibility in integrating new hardware features, and provides as much performance margin as possible.
Q&A

- Questions, Comments?

  - Contact: jrh@explorescientific.com
  - PMC-Eight Forum: Groups.io/ESPMC-Eight