

# How Planetary Resources uses TI MSP430™ MCUs to discover Earth's resource from space

*“The MSP430 FRAM microcontroller is a key element of our spacecraft avionics architecture. It's extremely low-power requirements make it very well suited to the spacecraft environment. It has been great working with TI to integrate this element into our spacecraft and I am really looking forward to seeing its performance on orbit.”*



## Customer Challenge

---

### *What problems was the customer trying to solve?*

There is a significant interest in Earth observing technology and in particular development of imaging products in bands outside of the visible spectrum. Within the spacecraft, there is a high demand to reduce power consumption while keeping more elements of the ship powered or in active mode.

## Customer Solution

---

### *How did the customer solve that challenge? What aspects of the TI device enabled them to solve that challenge?*

The Arkyd series of spacecraft by Planetary Resources are unique in that its mission is to mine these asteroids. The advanced Earth observation platform on-board, Ceres, delivers affordable, on-demand Earth intelligence of our natural resources from any spot on the planet. Ceres uses ultra-low-power MSP430™ FRAM microcontrollers to help maintain the strict power budget of the spacecraft.

## Customer Benefits

---

### *What do these technological advancements mean for the end-product users?*

The Ceres analyzes the spectral signatures of crops and provides customized information to growers, identifies energy and mineral resources and monitor pipelines and remote infrastructure. The system can also track toxic algae blooms, monitor global water quality and enable the detection of wildfires in their earliest stages.

## Challenge

The challenge of developing a platform that meets the size, weight and power requirements of a small spacecraft platform requires components that can fit within a very constrained and demanding operating environment. The range/number of components that fit within the operational envelope for a space application is limited. As a result, spacecraft avionics platform designs are often limited in what they can accomplish by virtue of the capabilities of the components available to develop the designs with.

## Solution

*How did the customer solve that challenge? What aspects of the TI device enabled them to solve that challenge?*

Over time, humans have developed technology to look deeper and more intelligently into the world around them – enabling us to leverage information beyond what the eye can see. Ceres is an advanced Earth imaging business using Planetary Resources' Arkyd 100 spacecraft. With just 10 satellites, the Ceres constellation provides weekly hyperspectral and mid-wave infrared data for any spot on Earth at a lower cost than existing multispectral data. Ceres uses TI's MSP430 FRAM MCUs to provide fast and low power writes that enable longer system run-time on the limited resources that space offers. Additionally, the MSP430 FRAM MCUs integrated analog to digital converter (ADC) and peripherals provided the ability to complete the design and collect telemetry/performance metrics on the instruments without the need for a significant number of additional components.

## Customer benefits

*What do these technological advancements mean for the end-product users?*

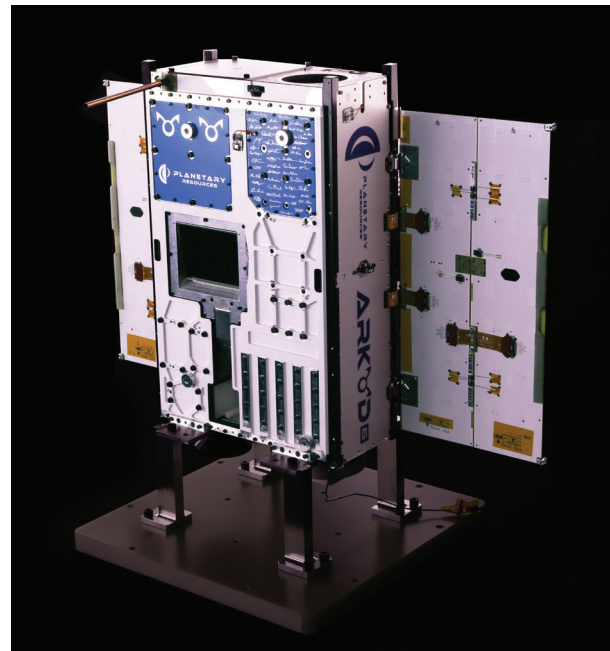
Providing deeper and more intelligent data, Ceres uses infrared and hyperspectral imaging to see the unseen and obtain more data in every pixel from space. The mid-wave infrared provides

night-imaging capabilities, temperature mapping and water content measurements, while the hyperspectral offers spectral fingerprinting, material identification and planet phenotyping. When deployed as a constellation with daily revisit rates anywhere on the planet, this advanced sensor platform becomes a powerful source of actionable, high-value, Earth intelligence.

## Application

*What did the customer design? What is it used for?*

Planetary Resources saw an opportunity to bring more intelligence and capabilities at a lower cost to satellites orbiting the Earth to deliver valuable information-rich data to markets today. In order to achieve this, Planetary Resources needed an ultra-low-power microcontroller that provided flexible memory, low-power consumption and multiple peripheral options. This is where the TI MSP430 FRAM microcontrollers came into play. In particular, being able to apply the same microcontroller to many different design areas reduced the development time and software complexity. It also allowed for significant design re-use from board to board.



The platform bar is a trademark of Texas Instruments. All other trademarks are the property of their respective owners.

## IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ("TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>), [evaluation modules](#), and [samples](http://www.ti.com/sc/docs/sampterm.htm) (<http://www.ti.com/sc/docs/sampterm.htm>).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2017, Texas Instruments Incorporated