

Dual-Band MWIR/LWIR Radiometer for Absolute Temperature Measurements

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ABSTRACT

A Dual-band Radiometer (DBR) has been developed to accurately measure temperature at long ranges. Key to the DBR is a dual-band, quantum well infrared photodetector (QWIP) focal plane array (FPA) that integrates within each pixel both mid-wavelength infrared (MWIR) and long-wavelength infrared (LWIR) spectral sensitivity. A vertically-integrated, two-color FPA eliminates with inter-band optical distortions, temperature-induced alignment errors, and improves radiometric measurement accuracy.

The DBR system is sensitive to human targets, yet minimally sensitive to atmospheric conditions, enabling accuracy over the widest possible range of global conditions by using Two-color Imaging Radiometry (TCIR) to establish a target's absolute temperature within $\pm 1^\circ\text{C}$. The benefits of TCIR for greybody measurements are absolute atmospheric transmission values are not required and uncorrelated shifts in the spectral band transmission cause minimal error.

The system is packaged with an eye-safe laser rangefinder, GPS, and weather station suite, which provides real-time atmospheric measurements. These measurements are input to the USAF MOSART predictive atmospheric codes, which are used for real-time field calibration of the data. The magnification necessary to resolve facial features from 200 m to 750 m range requires a custom designed 6" diameter, $\phi 7$ telescope with temperature-stable optical alignment over a wide range of operational temperatures.

Keywords: Radiometer, Two-Color Imaging Radiometry, TCIR, quantum well infrared photodetector, QWIP, thermography, infrared, Active Denial System, ADS, MOSART

1. INTRODUCTION

Accurate long-range temperature measurements are useful for a number of important applications. As example, in countless battlefield and emergence situations, such as those requiring triage, vital physiological parameters, such as skin temperature, must be measured when direct contact is not possible (Figure 1). The requirement driving the design and development is an accurate, long range, imaging radiometer capable of measuring the temperature of human faces within $\pm 1^\circ\text{C}$ at distances up to 750 m.

One application driving such requirements is the joint service Active Denial System (ADS). The ADS program is a breakthrough non-lethal technology that uses millimeter-wave electromagnetic energy to stop, deter, and turn back an advancing adversary from relatively long range. It is expected to save countless lives by providing a way to stop individuals without causing injury, before a deadly confrontation develops. Non-lethal technologies can be used for protection of Defense resources, peacekeeping, humanitarian missions, and other situations in which the use of lethal force is undesirable. The system is intended to protect military personnel against small-arms fire. The technology was developed by the Air Force Research Laboratory and the Department of Defense's Joint Non-lethal Weapons Directorate.

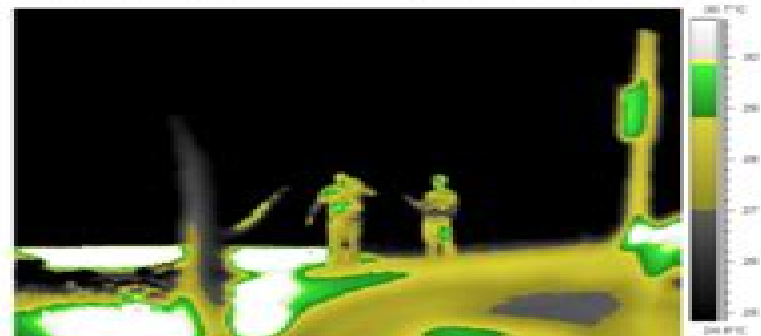


Figure 1: 30 meter LWIR QWIP Images with dual-isothermal thresholding (green $\Delta 1^\circ\text{C}$ above 29°C and yellow $\Delta 3^\circ\text{C}$ above 27°C).

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Infrared Thermal Imaging Michael Vollmer, Klaus-Peter Möllmann, 2018-02-20 This new up to date edition of the successful handbook and ready reference retains the proven concept of the first covering basic and advanced methods and applications in infrared imaging from two leading expert authors in the field All chapters have been completely revised and expanded and a new chapter has been added to reflect recent developments in the field and report on the progress made within the last decade In addition there is now an even stronger focus on real life examples with 20% more case studies taken from science and industry For ease of comprehension the text is backed by more than 590 images which include graphic visualizations and more than 300 infrared thermography figures The latter include many new ones depicting for example spectacular views of phenomena in nature sports and daily life Passive Infrared Remote Sensing of Clouds and the Atmosphere ,1993 Corrosion Management of Seawater Cooling Systems Francois Ropital, Valerie Bour Beucier, Antoine Surbled, 2024-06-15 *Corrosion Management of Seawater Cooling Systems* Volume 71 provides an overview on main seawater heat exchanger systems different forms of corrosion biocide treatments corrosion scale inhibitors materials used coatings and cathodic protection maintenance and monitoring and control The book will be a valuable reference resource for academics technicians and engineers who are interested in the corrosion management of seawater cooling systems The evolution of practices in terms of sustainability materials choice treatment selection and changes to regulations have demonstrated the need to establish this new guide on recommended best practices that support corrosion management and the development of seawater heat exchangers Seawater is considered an attractive resource for utilities in many industries such as power plants refineries and chemical plants Seawater cooling systems are used in heat exchangers in once through cooling water systems and for recirculating cooling water systems The metallurgy and materials used in these facilities need to be compatible with seawater and allow good corrosion control As seawater composition and suspended solids can cause corrosion scaling fouling microbiological growth and macrofouling problems this book is a necessary addition to the conversation Covers key technological developments in corrosion management of seawater cooling systems Includes coverage of seawater heat exchangers Provides information on many different forms of corrosion Presents tactics for the selection of materials corrosion protections inhibitors coatings cathodic protection Discusses maintenance control monitoring and inspection *Optical Payloads for Space Missions* Shen-En Qian, 2016-01-26 *Optical Payloads for Space Missions* is a comprehensive collection of optical spacecraft payloads with contributions by leading international rocket scientists and instrument builders Covers various applications including earth observation communications navigation weather and science satellites and deep space exploration Each chapter covers one or more specific optical payload Contains a review chapter which provides readers with an overview on the background current status trends and future prospects of the optical payloads Provides information on the principles of the optical spacecraft payloads missions background

motivation and challenges as well as the scientific returns benefits and applications

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