

FLIR Lepton with Radiometry Quickstart Guide

Document Number: 102-PS245-76 Rev 100



Table of Contents

Revision History	1
Scope	1
Compensation for Final System Integration.....	2
Background	2
Application.....	2
Requirements	2
Procedure	3

Revision History

Version	Date	Comments
100	December 8, 2016	Initial Release

Scope

This document describes a simplified subset of the parameter updates necessary for integrating the Lepton with Radiometry configuration (80x60 part number: 500-0763-01) into a final system. For a more in depth discussion of the radiometry background principles and sources of error, please refer to the Advanced Radiometry Application Note (document number 102-PS245-75).

Information on this page is subject to change without notice.
102-PS245-76, Lepton with Radiometry Quickstart Guide, Rev:100



The World's Sixth Sense™

Compensation for Final System Integration

Background

The Lepton with Radiometry is calibrated at the factory for accurate measurement of a scene with 100% emissivity in close proximity to the camera. Factors such as scene emissivity and unwanted signal from sources other than the scene will influence the measurement accuracy of a real scene. Compensation for the factors that enter as a result of integrating the Lepton in a complete system is the subject of this document.

The Lepton with Radiometry calibrated values and parameter defaults assume no window or 100% window transmission, but typical systems in which the Lepton is integrated include a window which needs to be characterized to achieve accurate radiometry. The window must be transmissive in the long wave infrared (LWIR) band, specifically 7-14microns. Typical materials include Ge, ZnS, and Si where the average transmission across the LWIR band would be provided by the window supplier or preferably characterized for best accuracy as described in the subsequent section. The temperature of the window should also be characterized to determine the additional irradiance it adds to the system. In use, the window temperature will vary as a function of the environment temperature which can be compensated for by either run-time measurement (i.e. including a temperature sensor) or simply characterizing the value at a particular temperature and relating it to the temperature sensors included in the Lepton module.

For best radiometric accuracy, it is recommended that instead of utilizing the transmission values provided by the supplier, that the window transmission and window temperature are characterized on a small sample set in the final system to be applied to all systems using the same configuration. The window transmission should be characterized first, then the window temperature at a single ambient temperature point at a minimum. Note that the window temperature measurement error is high when the window transmission is very high, but in this case the impact of this parameter is lower. The following section discusses the procedure for characterizing the window parameters which are effectively correcting all gain (e.g. window transmission) and offset (e.g. reflection and/or irradiance from the window) errors in the final system.

Application

Requirements

- Two black body sources with known temperatures and emissivity, e.g. 20°C and 60°C
- Software interface to communicate with Lepton over i2c

Information on this page is subject to change without notice.
102-PS245-76, Lepton with Radiometry Quickstart Guide, Rev:100

FLIR Lepton with Radiometry Quickstart Guide

- Video interface to view VoSPI
- Final enclosure with the window

Procedure

- 1) Power on the Lepton within the final system (including the window).
- 2) Align the camera with the black body source such that the surface of the black body subtends at a minimum the 10x10 center pixels. Ensure the black body is far enough away to be in focus. If the black body source is relatively hot, this can cause undesired camera heating affects, so a shield may be used until the data collection starts.
- 3) Ensure the black body source is stable in temperature. Ensure the camera temperature is stable. For example, to verify the camera temperature is stable, read back the FPA temperature via the LEP_GetSysFpaTemperatureKelvin() C-SDK command multiple times over the course of 10 seconds.
- 4) Change the Flat Field Correction (FFC) mode to “Manual” to ensure no FFCs occur during the calibration via the LEP_SetFfcShutterModeObj() C-SDK command.
- 5) Perform an FFC via the LEP_RunSysFFCNormalization() C-SDK command and wait at least one minute prior to data collection.
- 6) Set the TLinear state to disabled via the LEP_SetRadTLinearEnableState() C-SDK command.
- 7) Capture a frame or record the mean of the center pixels. The mean output of the center region of interest, ideally smaller than the black body (e.g. 6x6), is variable S_{1Win} . Record the FPA temperature (T_{FPA}) in degrees Celsius at the time of this measurement (either in the telemetry data or via i2c query).
- 8) Move the camera to view the second, hotter black body source.
- 9) Capture a frame or record the mean of the center pixels. The mean output of the center ROI is variable S_{2Win} .
Note: Alternatively, both black body sources can be viewed simultaneously and the captured frame analyzed with the appropriate region of interest for each of the S_{1Win} and S_{2Win} measurements.
- 10) Remove the window and repeat the previous steps where the new measurements without the window are variables S_{1NoWin} and S_{2NoWin} .
- 11) Calculate the average percent transmission reduction due to the window with the following equation:

$$\tau_{Win} = \epsilon \cdot \frac{S_{2Win} - S_{1Win}}{S_{2NoWin} - S_{1NoWin}}$$

Information on this page is subject to change without notice.
102-PS245-76, Lepton with Radiometry Quickstart Guide, Rev:100



The World's Sixth Sense™

FLIR Lepton with Radiometry Quickstart Guide

12) Calculate the window temperature with the following equations. The flux due to the window temperature $W(T_{Win})$ must first be calculated before converting to temperature T_{Win} with the RBFO parameters that were calibrated at the factory on a per-camera basis; the RBFO parameters can be read from the camera software via the `LEP_GetRadRBFOExternal0()` C-SDK command. The background temperature T_{Bkg} must be assumed and the corresponding flux $W(T_{Bkg})$ calculated using the RBFO function. The expected blackbody signal $W(T_{BB})$ must also be calculated with the known black body temperature and the RBFO function.

$$W(T_{Win}) = \frac{S_{1Win} - \tau_{Win}\{\epsilon W(T_{BB}) + (1 - \epsilon)W(T_{Bkg})\}}{(1 - \tau_{Win})}$$

$$T_{Win} = B / \ln\left(\frac{R}{W(T_{Win}) - O} + F\right)$$

where

- ϵ = emissivity of the black body
- S_{1Win} = measured signal against black body 1
- τ_{Win} = characterized window transmission
- $W(T_{BB})$ = expected signal against the black body
- $W(T_{Bkg})$ = flux due to background temperature
- $R, B, F,$ and O = camera specific constants readable via CCI

13) Write the characterized external scene parameters τ_{Win} and T_{Win} to camera software via the `LEP_SetRadFluxLinearParams()`.

14) Verify accuracy against both black body sources to confirm the newly characterized parameters.

15) If it is not practical to measure the window temperature in use, it can be estimated by using nearby known temperatures such as that of the focal plane array (T_{FPA}) plus an offset determined experimentally. This constant offset may be determined with the room temperature ambient data described above, where $T_{FPA}(\text{measured})$ is determined in Step 7 and $T_{Win}(\text{measured})$ is determined in Step 12:

$$\text{Offset} = T_{Win}(\text{measured}) - T_{FPA}(\text{measured})$$

$$T_{Win}(\text{runtime}) = T_{FPA}(\text{runtime}) + \text{Offset}$$

Note that updating the window temperature in runtime based on T_{FPA} or an additional temperature sensor requires constant update of the T_{Win} parameter in software via `i2c`.

Information on this page is subject to change without notice.
102-PS245-76, Lepton with Radiometry Quickstart Guide, Rev:100



The World's Sixth Sense™

FLIR Lepton with Radiometry Quickstart Guide

© FLIR Commercial Systems, 2014. All rights reserved worldwide. No parts of this manual, in whole or in part, may be copied, photocopied, translated, or transmitted to any electronic medium or machine readable form without the prior written permission of FLIR Commercial Systems

Names and marks appearing on the products herein are either registered trademarks or trademarks of FLIR Commercial Systems and/or its subsidiaries. All other trademarks, trade names, or company names referenced herein are used for identification only and are the property of their respective owners.

This product is protected by patents, design patents, patents pending, or design patents pending.

If you have questions that are not covered in this manual, or need service, contact FLIR Commercial Systems Customer Support at 805.964.9797 for additional information prior to returning a camera.

This documentation is subject to change without notice.



This equipment must be disposed of as electronic waste. Contact your nearest FLIR Commercial Systems, Inc. representative for instructions on how to return the product to FLIR for proper disposal.

FCC Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested and approved under the rules of the Federal Communications Commission (FCC) before the end-product may be offered for sale or lease, advertised, imported, sold, or leased in the United States. The FCC regulations are designed to provide reasonable protection against interference to radio communications. See 47 C.F.R. §§ 2.803 and 15.1 et seq.

Industry Canada Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested for compliance with the Interference-Causing Equipment Standard, Digital Apparatus, ICES-003, of Industry Canada before the product incorporating this device may be: manufactured or offered for sale or lease, imported, distributed, sold, or leased in Canada.

Avis d'Industrie Canada. Cet appareil est un sous-ensemble conçu pour être intégré à un autre produit afin de fournir une fonction de caméra infrarouge. Ce n'est pas un produit final destiné aux consommateurs. Une fois intégré à un dispositif hôte, le produit final va générer, utiliser et émettre de l'énergie radiofréquence qui pourrait provoquer de l'interférence radio. En tant que tel, le produit final intégrant ce sous-ensemble doit être testé pour en vérifier la conformité avec la Norme sur le matériel brouilleur pour les appareils numériques (NMB-003) d'Industrie Canada avant que le produit intégrant ce dispositif puisse être fabriqué, mis en vente ou en location, importé, distribué, vendu ou loué au Canada.

EU Notice. This device is a subassembly or component intended only for product evaluation, development or incorporation into other products in order to provide an infrared camera function. It is not a finished end-product fit for general consumer use. Persons handling this device must have appropriate electronics training and observe good engineering practice standards. As such, this product does not fall within the scope of the European Union (EU) directives regarding electromagnetic compatibility (EMC). Any end-product intended for general consumer use that incorporates this device must be tested in accordance and comply with all applicable EU EMC and other relevant directives.

Information on this page is subject to change without notice.
102-PS245-76, Lepton with Radiometry Quickstart Guide, Rev:100



The World's Sixth Sense™

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for [Video IC Development Tools](#) category:

Click to view products by [SparkFun](#) manufacturer:

Other Similar products are found below :

[TW6872-NA1-CR-EVALZ](#) [MAX4313EVKIT](#) [1937](#) [SEN0173](#) [EVAL-ADV7282AMEBZ](#) [EVAL-ADV7281AMEBZ](#) [EBK-GS2972-00](#) [LF-PNV-EVN](#) [EP-DCOV2735-F36](#) [UP-PACK-VISION-002](#) [3099](#) [3100](#) [3202](#) [397](#) [EVAL-AD9984AEBZ](#) [EVAL-ADV7180-32EBZ](#) [EVAL-ADV7180LFEBZ](#) [EVAL-ADV7180LQEBZ](#) [EVAL-ADV7181CLQEBZ](#) [EVAL-ADV7280EBZ](#) [EVAL-ADV7281MAEBZ](#) [EVAL-ADV7281MEBZ](#) [EVAL-ADV7282EBZ](#) [EVAL-ADV7282MEBZ](#) [EVAL-ADV7341EBZ](#) [EVAL-ADV7393EBZ](#) [107784](#) [108024](#) [108025](#) [108320](#) [108329](#) [VM800BU35A-PL](#) [VM801B43A-BK](#) [VM801B50A-BK](#) [VM801P50A-BK](#) [VM801P43A-BK](#) [DFR0498](#) [ESP-EYE](#) [82535IVCQSPL04N](#) [82634DSQSCR](#) [030-0276-0101_A](#) [QC-DB-I10006](#) [DP-VIP-I-EVN](#) [DP-VIP-O-EVN](#) [USB3-VIP-EVN](#) [CS-DEPTHAI-05](#) [CS-DEPTHAI-06](#) [AGB1N0CS-GEVK](#) [PIM365](#) [PIM366](#)