

FLIR Systems

Jeff Dale



The World's Sixth Sense™

The World's Sixth Sense

Improving the way we live by bringing innovative sensing technologies into **daily life**.



Solutions for Military & Defense



Solutions for Your Home



Solutions for The Outdoors



Solutions for Maritime



Raymarine

Solutions for WORK



Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.



The World's Sixth Sense™

TM

What do you want to **measure**?





Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.



The World's Sixth Sense™



EC&M
Product
OF THE
Year
Competition **14**

Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.

FLIR

The World's Sixth Sense™

THERMAL IMAGING

FINDING THE PROBLEM

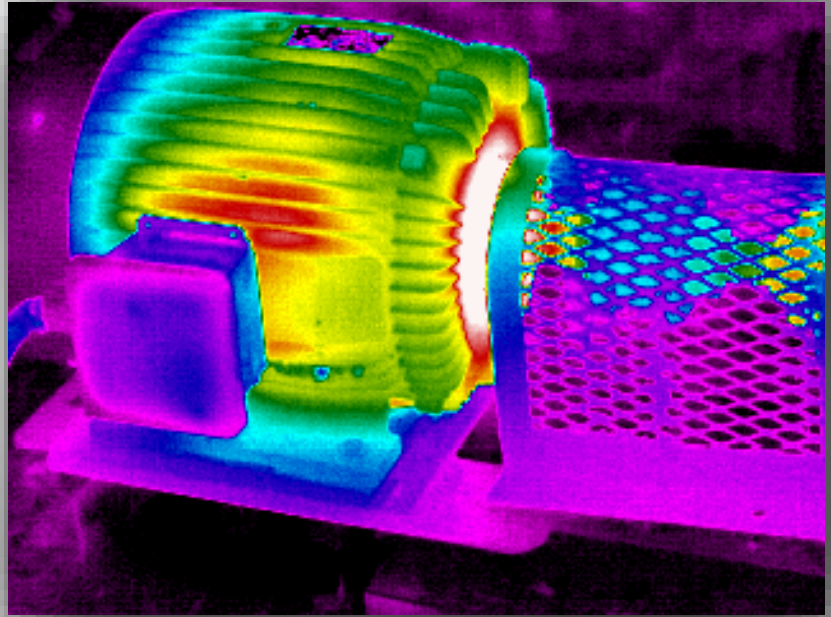
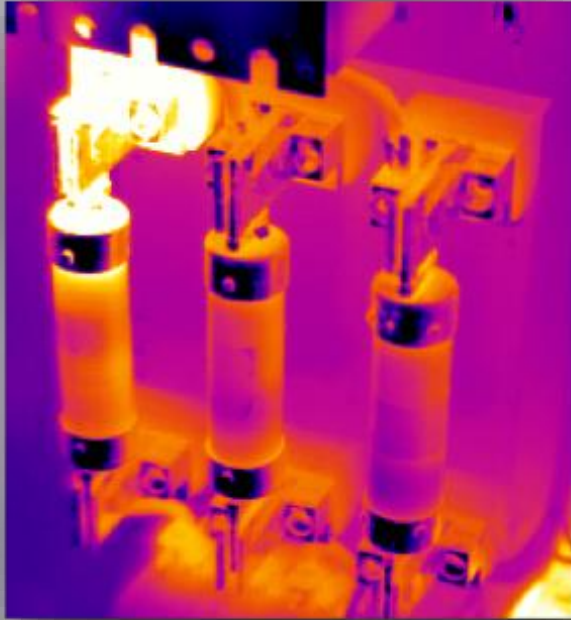
Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.



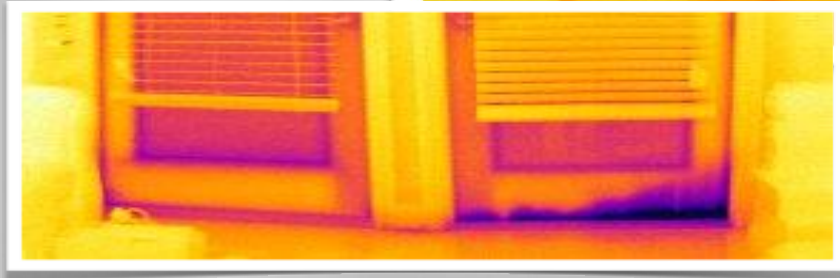
The World's Sixth Sense™

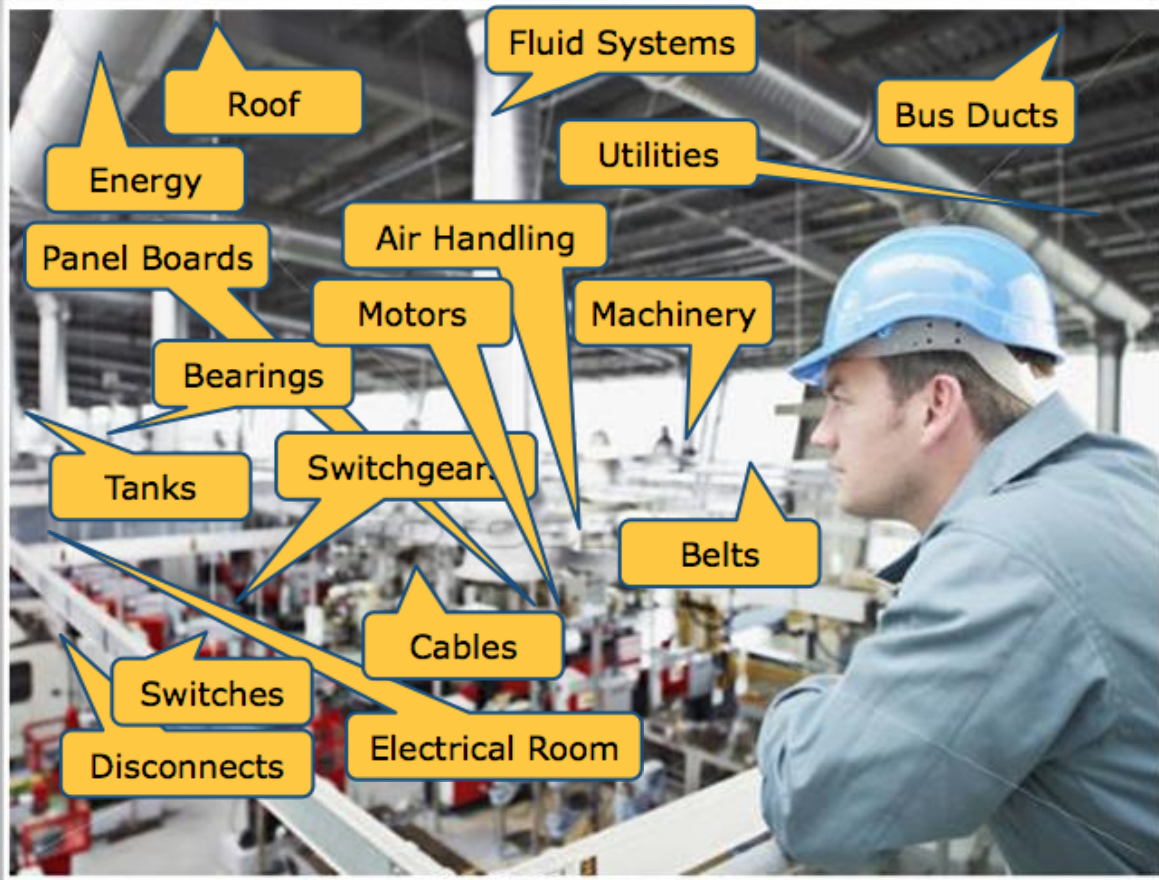
Why do we want to see heat?



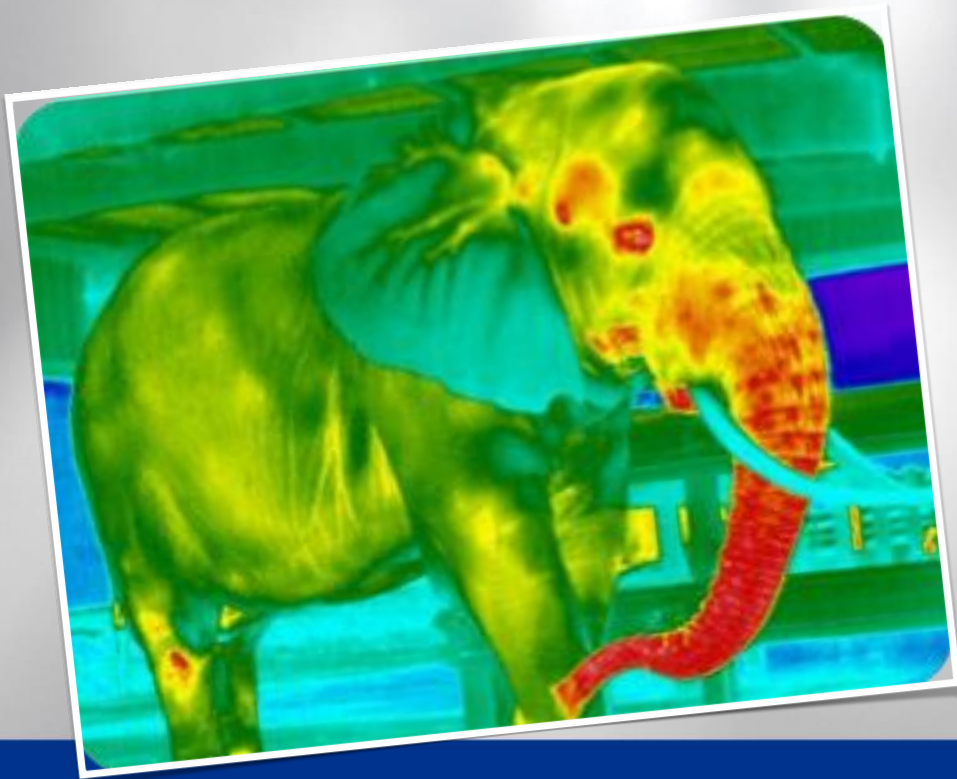
Heat anomalies tend to indicate problems

What about absence of heat?

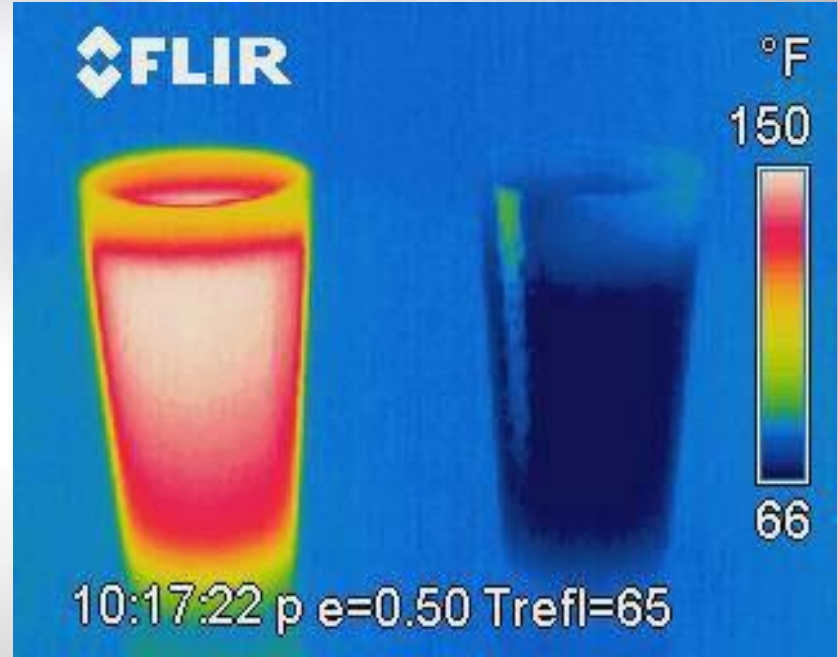




What is a Thermal Imager?

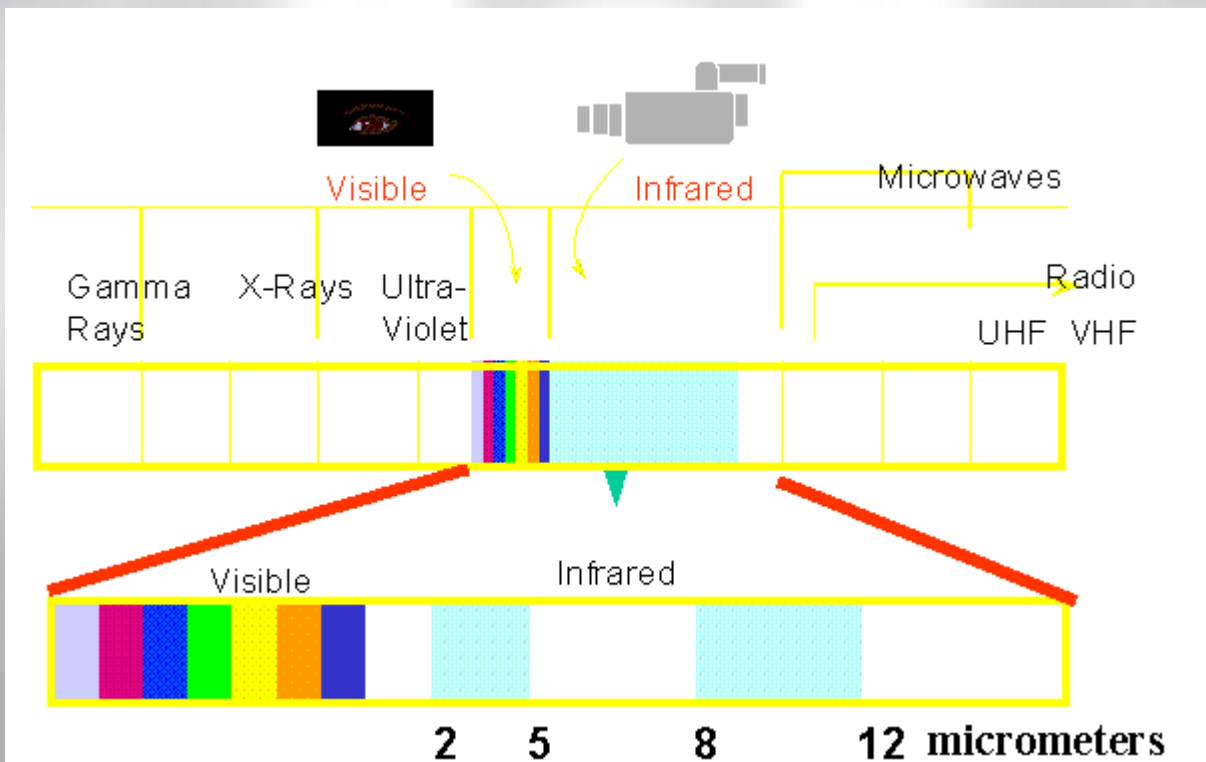


A tool that allows one to “*see*” heat



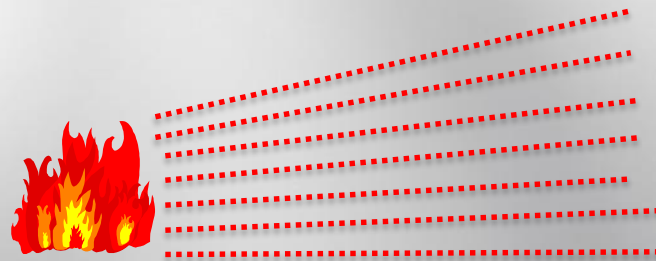
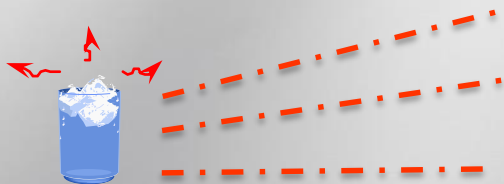
Allows you to see things in a different light.

What is Infrared?

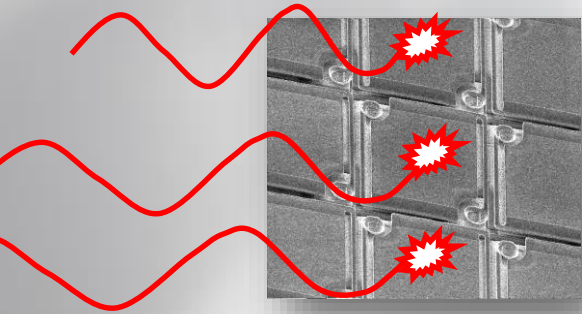


How do thermal cameras work?

- IR waves are emitted by all objects
- IR radiation increases with temperature



How do thermal cameras work?



*Photons Impact and
HEAT the Detector Element.*

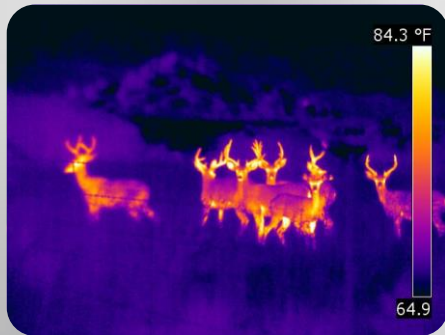


Stefan - Boltzmann Law

$$E = \epsilon \sigma T^4$$



Advanced Calculations



22	39	44	86	35	25
23	56	48	53	46	58
25	45	83	35	45	55
22	39	44	86	83	25
23	83	95	53	46	58
25	28	81	35	45	55

What's the Difference?



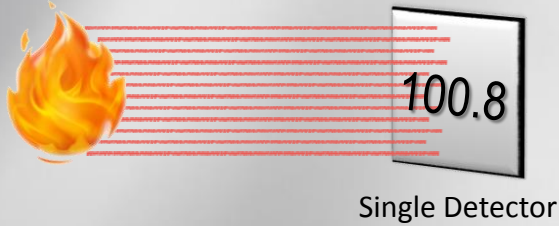
IR Thermometer



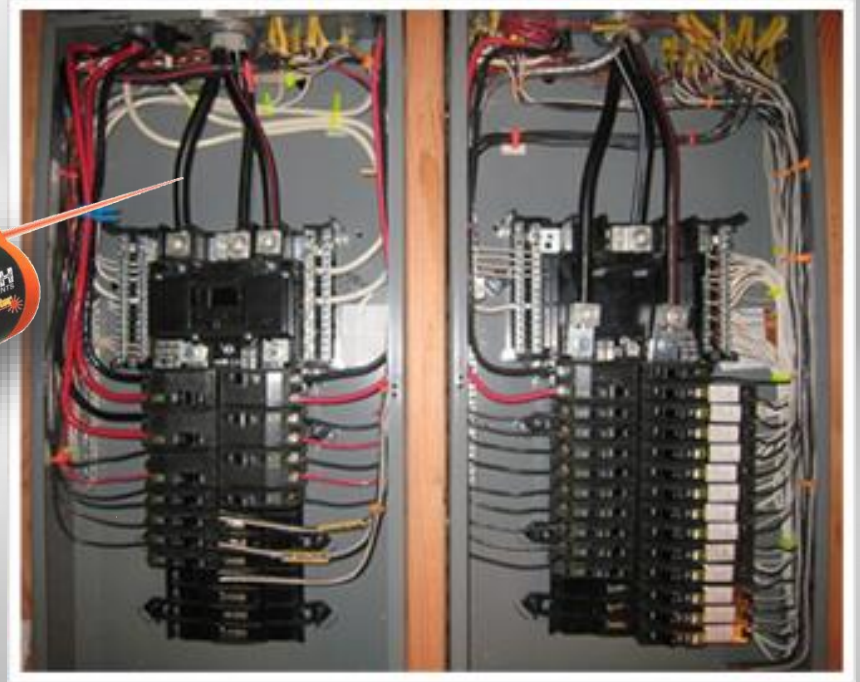
Thermal Camera

IR Thermometer (Spot Gun)

- Provides a single non-contact temperature reading



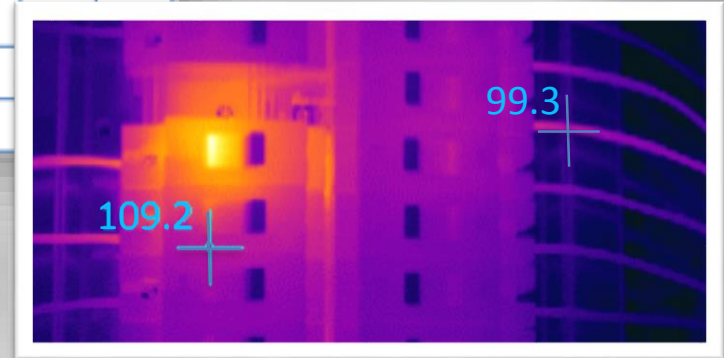
- No thermal image is provided



Thermal Camera

- All pixels provide *calibrated* temperature reading
- Calibrated Temperatures allow for color assignment
- Thermal image is provided
- Radiometric Data (temperature) is imbedded into every image

22	39	44	86	35	25
23	56	48	53	46	58
25	45	83	35	45	55
22	39	44	86		
23	56	95	53		
25		83	35		

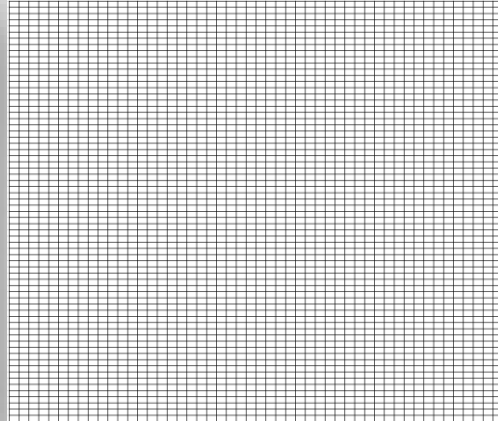
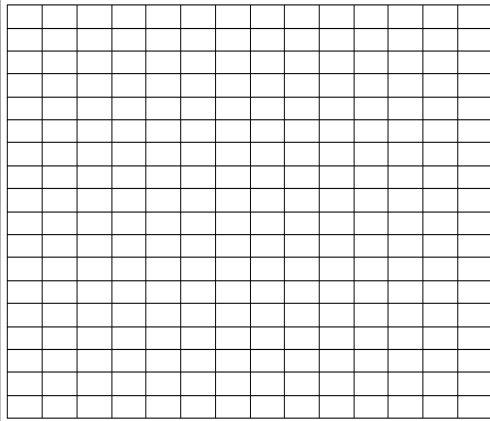


Important Specifications to Understand

- Resolution
- Spot Size

RESOLUTION

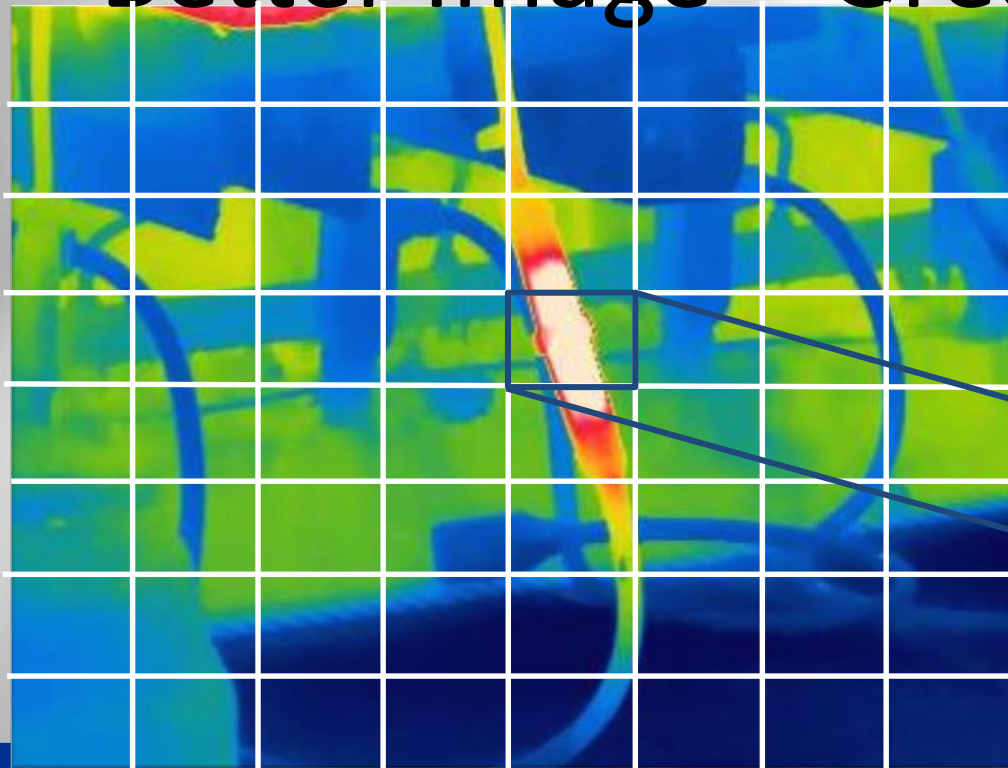
More pixels equates to higher density of measurement points



Less pixels typically result in lower quality image



Better Image = Greater Accuracy

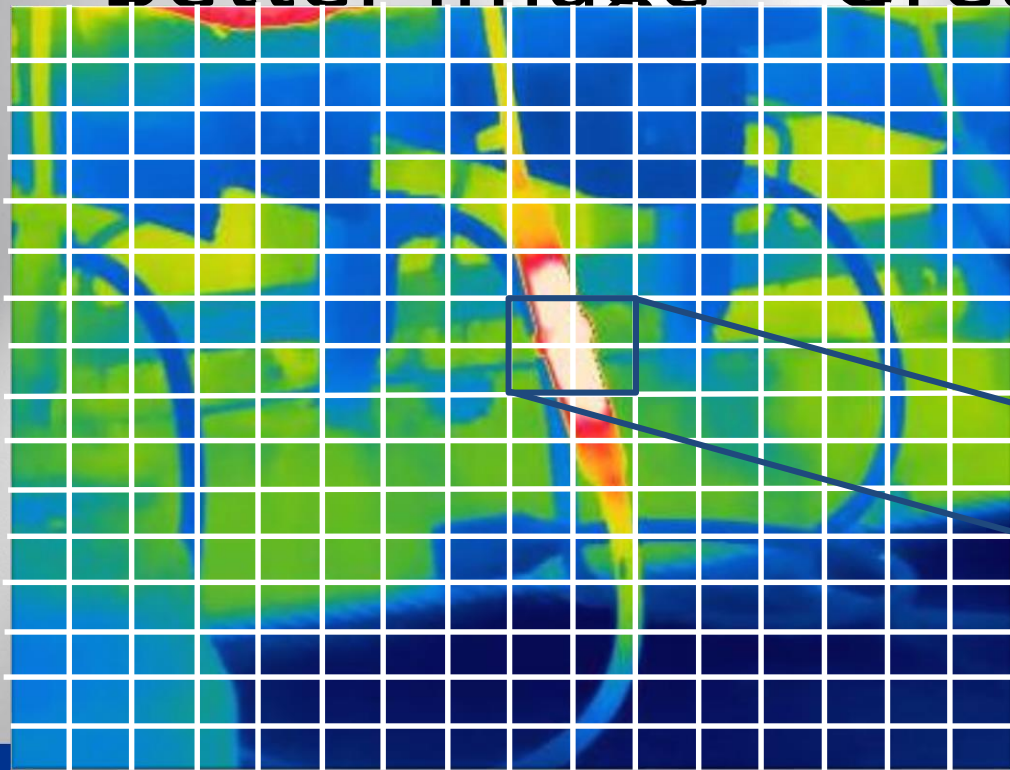


Temperature Data
Averaged From One Pixel
Covering Target Area

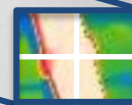


31.1°C

Better Image = Greater Accuracy

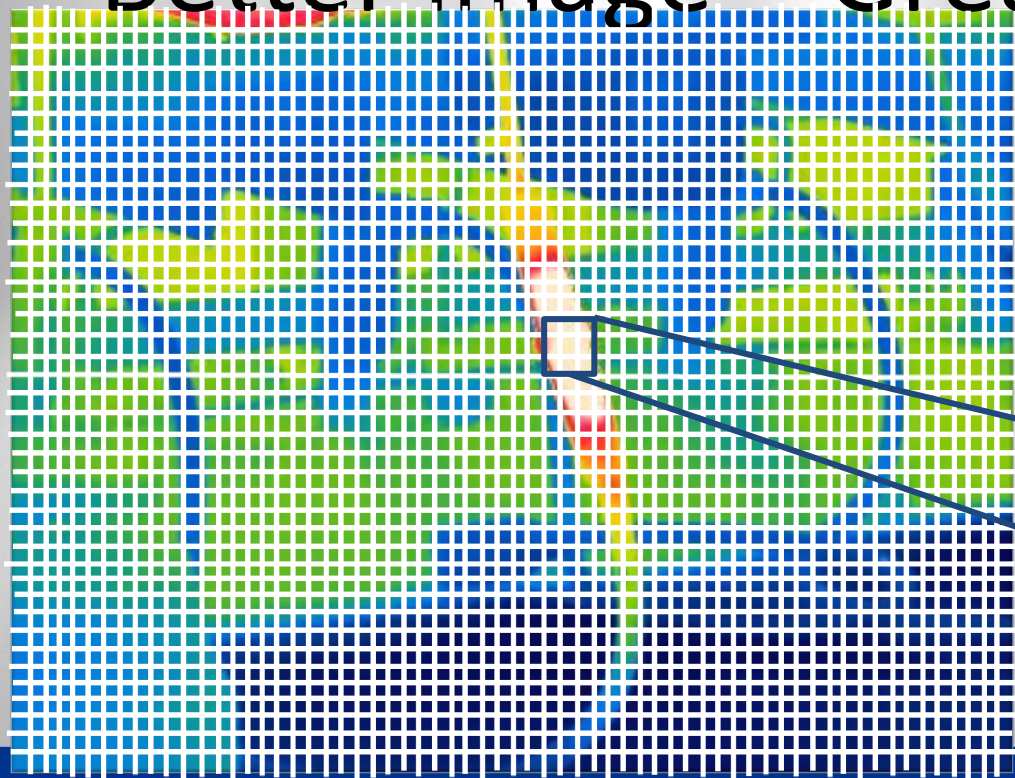


More Pixels on Target
Improves Measurement



40.8°C

Better Image = Greater Accuracy

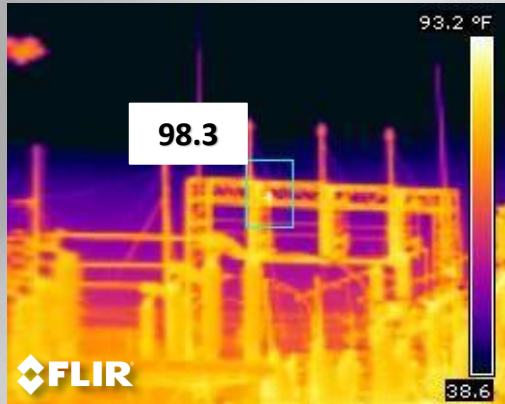


More Pixels Means More
Detail, More Accuracy

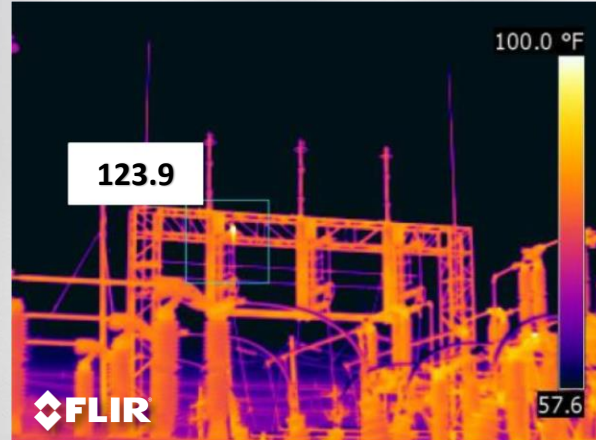


49.3°C

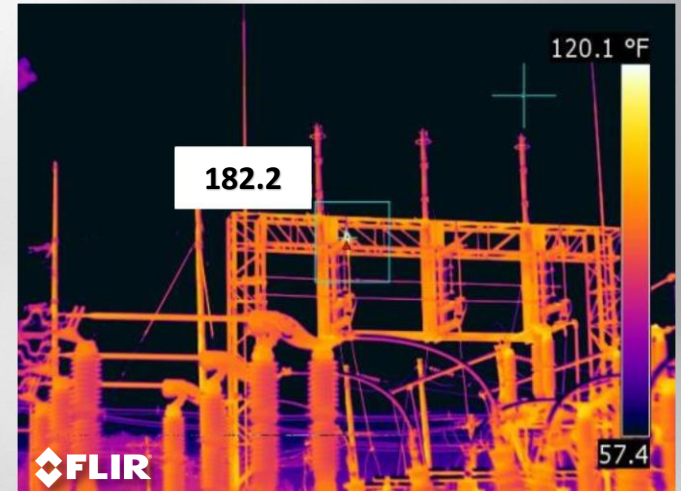
Improved Accuracy



320 x 240
76,800

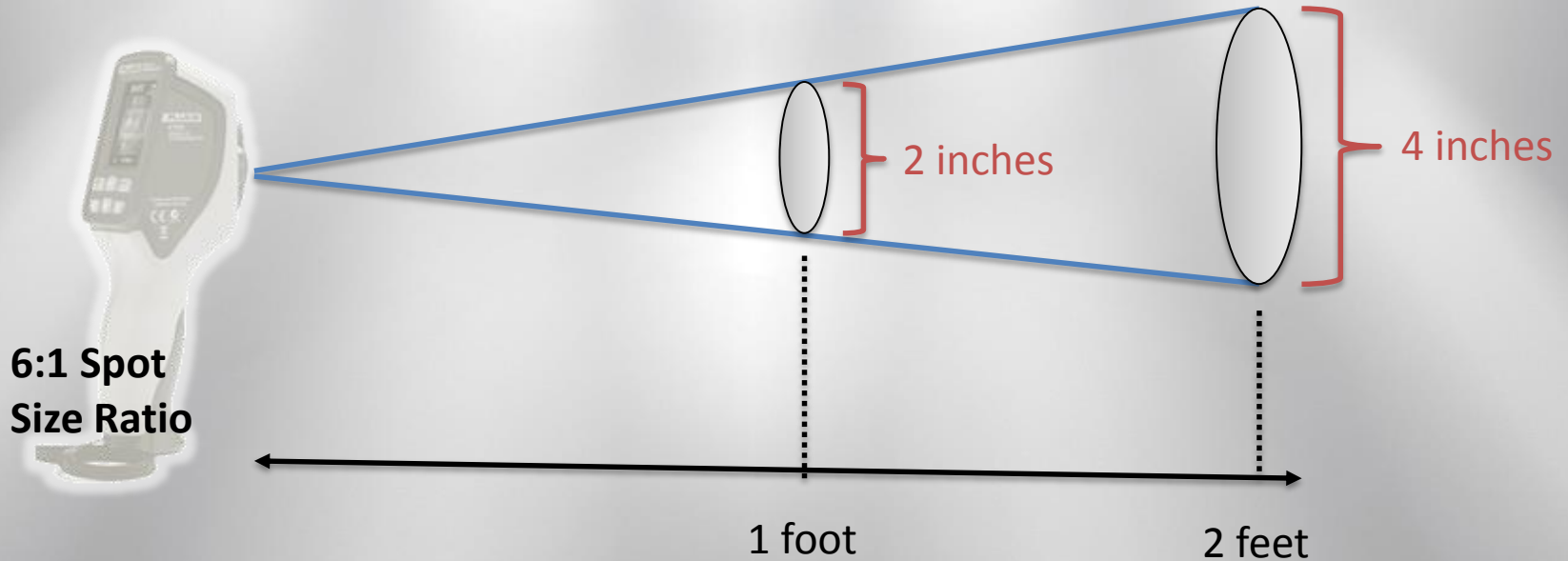


640 x 480
307,200



1024 x 768
786,432

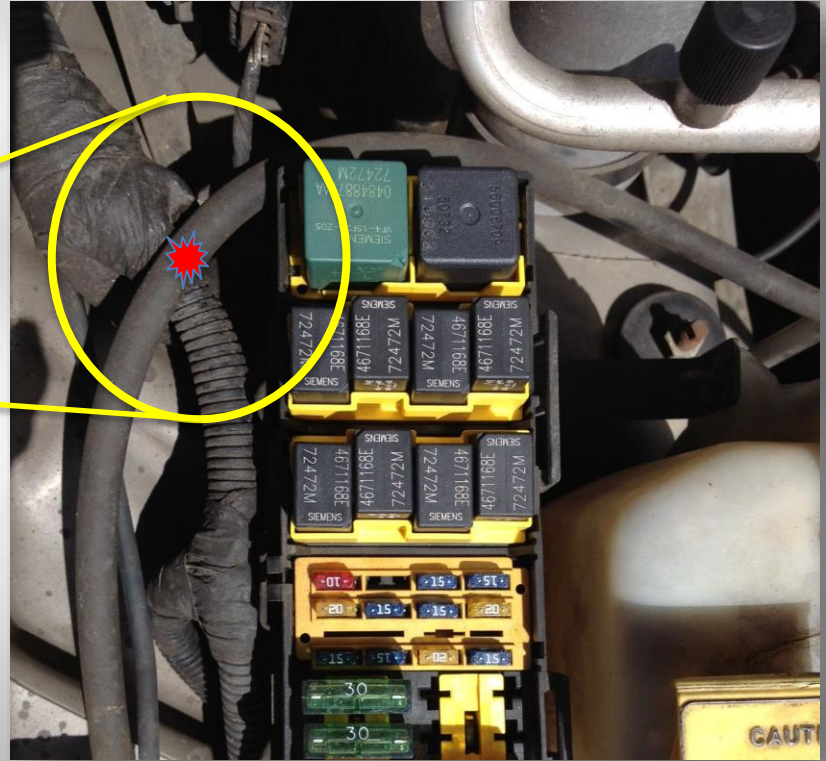
SPOT SIZE



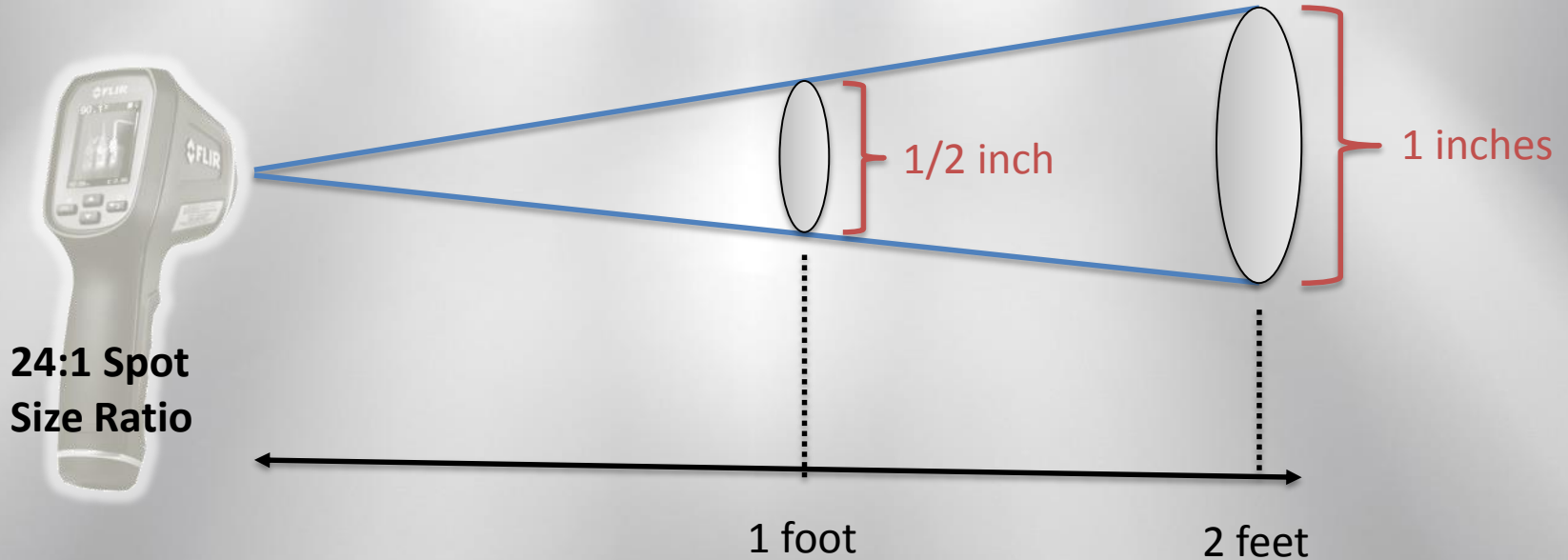
SPOT SIZE



**6:1 Spot
Size Ratio**



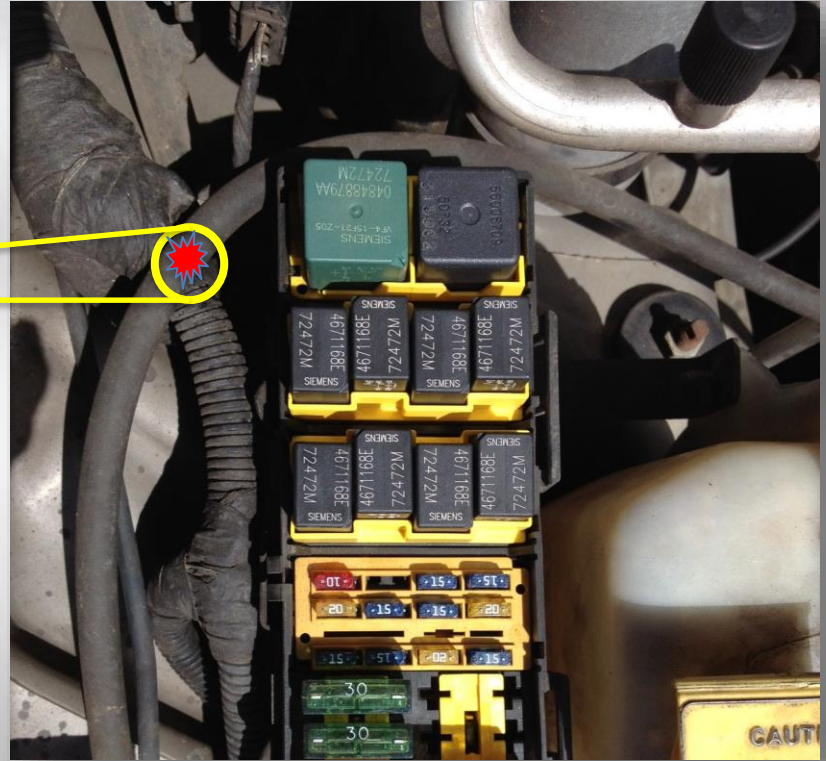
SPOT SIZE



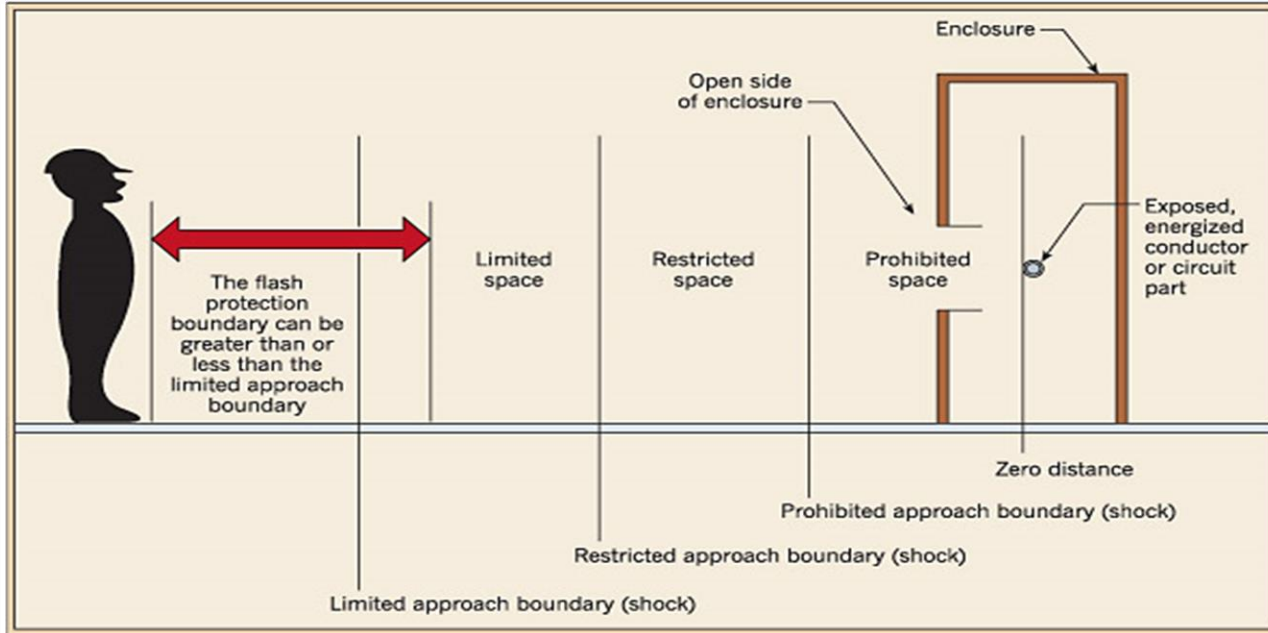
SPOT SIZE



**24:1 Spot
Size Ratio**



Why would you want a better spot size?



Better accuracy at a safer distance



...“but Infrared Cameras
are so expensive!”

Safety



InfraMation

Five Years of Infrared Results at CNA — March 2005 through June 2010

IR Thermography Saves Energy and Avoids Losses for CNA Clients

Thomas Gray
CNA Insurance

ABSTRACT

Electrical systems – for obvious reasons – are designed to be reliable. Like any complex system, electrical systems require periodic maintenance and inspection to ensure power is supplied to buildings and facilities in a safe and efficient manner.

Infrared (IR) thermography can detect heat in the form of infrared energy that is emitted from faulty equipment. Everything with a temperature above absolute zero releases thermal, or infrared, energy. The light composed of this energy isn't visible because its wavelength is too long to be detected by the human eye.

The higher an object's temperature, the greater the IR radiation it emits. IR thermography cameras can not only "see" this light, but can also delineate hot areas from cool areas.

INTRODUCTION

Insurance companies have traditionally focused on controlling the impact of property losses by using fire protection systems (such as sprinklers) to minimize losses when they happen. Rarely is a service offered that actually helps prevent losses and saves clients real money. IR thermography is such a service. A thermal imaging (IR) scan increases confidence in equipment, decreases the chance for fire loss, reduces energy costs, and helps avoid business interruption losses.

Certified IR thermographers can conduct scans on equipment to find potential problems in the early stages of breakdown or failure. Mechanical systems and key production equipment are also assessed during IR thermography. No interruption of production is typically required during the test. Section 21.17.5 of NFPA 70B-2005 edition recommends that building owners complete IR surveys annually. Other sources recommend every 3 to 5 years, depending on the number and level of faults found, but some recommend every 2 to 3 years.

From March 2005 through June 2010, our thermographers have conducted 6,445 IR surveys, averaging about 100 surveys per month. Using 22 (FLIR P65 model) IR cameras, our thermographers have found 47,077 faults (or deficiencies) for an average of 7.3 faults per report.

Electrical repair cost savings are estimated at \$500 for minor or intermediate faults and \$3000 for serious or critical faults. These estimates are based on typical industry experience. The four fault categories are based upon temperature differentials from the norm. Minor faults are 1°–9°F above the norm. Intermediate faults are 10°–34°F, serious faults are 35°–74°F, and critical faults are 75°F or greater above the norm.

Energy savings vary by temperature differential and current (amps). Energy savings can be calculated using a FLIR-created tool called "Indirect Power Calculations from Surface Temperatures" or estimated from a number of sample calculations and assumptions. The following are considered reasonable estimates – \$1.50/day for critical faults; \$0.75/day for serious; \$0.40/day for intermediate; and \$0.15/day for minor. A cost of \$0.15 per kilowatt-hour (KWH) is used to develop these estimates, but energy costs may be higher in some areas. We use 250 working days in a year (excluding 10 holidays) to estimate energy savings for each fault.

InfraMation 2010 Proceedings

2010-108-Gray

InfraMation

serious, and ten intermediate faults as a result of the survey. The critical fault (Figure 2) already showed visible evidence of charred insulation (Figure 3). If that fault had become a fire (and it was very close to doing so), the facility might have lost 100% of its contents' value due to a smoky electrical fire destroying processed fruit in storage. That is an estimated \$4 million loss avoided. The correction of the other faults saved the client an estimated \$40,000 in electrical repair costs, energy savings, and value of the IR survey.

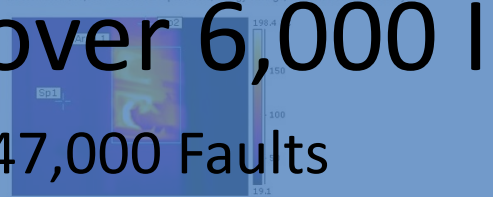


Figure 2. IR image of the outside of the panel.

The critical fault was located on the top conductor of the cover, there was immediate color change (red) (conductor) and some of the insulation had severely melted away. The temperature of the two bottom conductors was 100°F in Area 1. Sp2 notes a temperature of 182.9°F at the top conductor. Extreme heat and failure of electrical components can result in a fire with ensuing property damage and unplanned interruption of business operations. The fault electronics was contacted immediately to get the fault repaired due to the seriousness / severity of the fault. A temperature differential of greater than 75°F is considered a critical fault and



Figure 3. Visual image of panel showing damage.

SUMMARY

Our thermographers have identified one or more critical or serious faults on 3,067 surveys out of the total of 6,445 surveys completed so far. If we apply the \$750K "average" electrical fire estimate, that adds up to about \$2.4 billion in electrical fire losses avoided. Adding BI estimates raises the total even higher. Most of these

InfraMation 2010 Proceedings

2010-108-Gray

Results from over 6,000 IR Surveys

47,000 Faults

7.3 per survey

\$55M Saved

\$8,533 per Survey

Courtesy: Thomas Gray CNA Insurance



What is...

IGM **Infrared Guided Measurement**



IGM™



FLIR Clamp Meters



CM174 - \$499.99

- IGM!
- Spot Temp Measurement
- Safety
- Productivity

Thermal imaging devices are Imperative for troubleshooting for 3 Main Reasons:



- **SPEED**
- **ACCURACY**
- **DOCUMENTATION**

SPEED - Find The Problem *quickly!*



Proprietary - Confidential
Information and its use are
prohibited.

Systems Inc.

require US Government authorization for export purposes. Diversion contrary to US law is



The World's Sixth Sense™

SPEED - Find The Problem *quickly* *and SAFELY!*



Proprietary - C
Information an
prohibited.

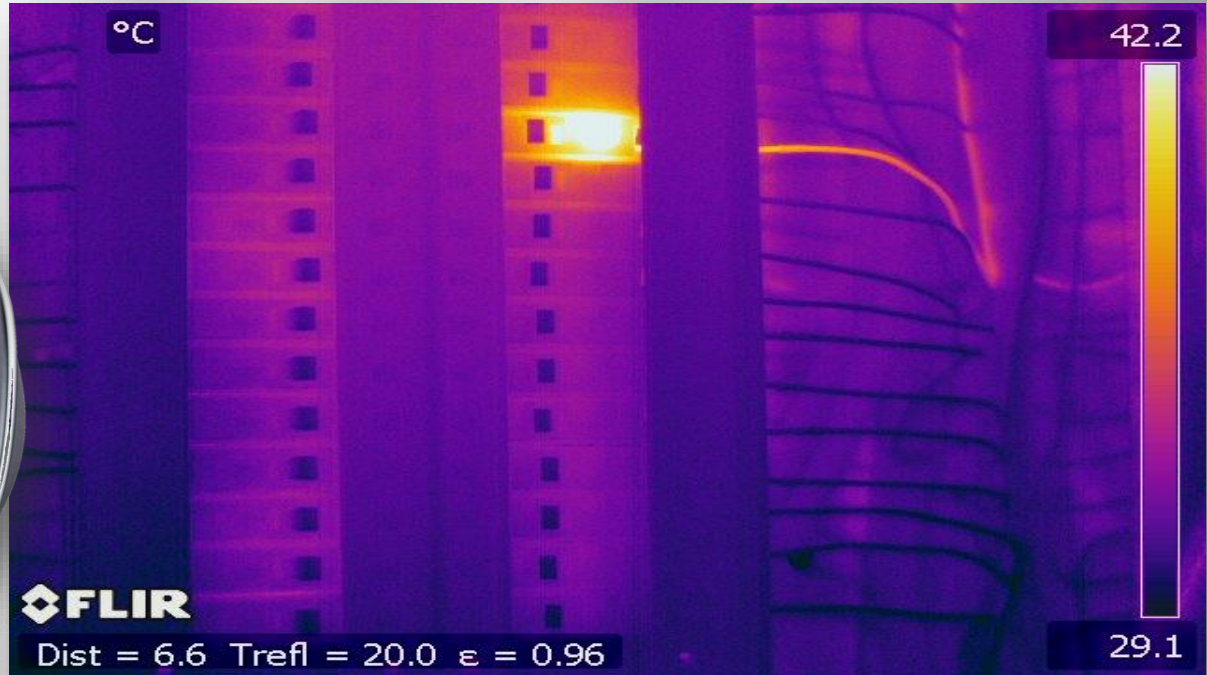
Systems Inc.

require US Government authorization for export purposes. Diversion contrary to US law is



The World's Sixth Sense™

ACCURACY - Pinpoint the Issue



Proprietary - Com
Information and
prohibited.

ms Inc.
quire US Government authorization for export purposes. Diversion contrary to US law is



The World's Sixth Sense™

ACCURACY - Pinpoint the Issue



Proprietary - Confidential Information and Trademarks Inc. require US Government authorization for export purposes. Divers



The World's Sixth Sense™

DOCUMENTATION of The Problem



FLIR Inspection Report

Report Date: 11/8/2010

Company: FLIR
Address: San Carlos, CA
Thermographer: Eric Hughes

Customer:
Site Address:
Contact Person:



Image and Object Parameters

Camera Model	FLIR T400
Image Date	5/15/2010 1:15:27 AM
Image Name	IR_0021.jpg
Emissivity	0.95
Reflected apparent temperature	68.0 °F
Object Distance	3.3 ft

Test Comments

Site	SC-8
Floor	2
Room	25a
Equipment	Fuse
Designation	548-2h
Maximum Load (Amps)	10
Root Cause	High Resistance Connection
Correction	Clean & Tighten All Related Connections



Let's Look at Some Applications....

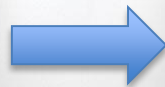
Finding electrical problems

Electrical Equipment

Loose connections
Dirty Connections
Corroded Connections



impedes current



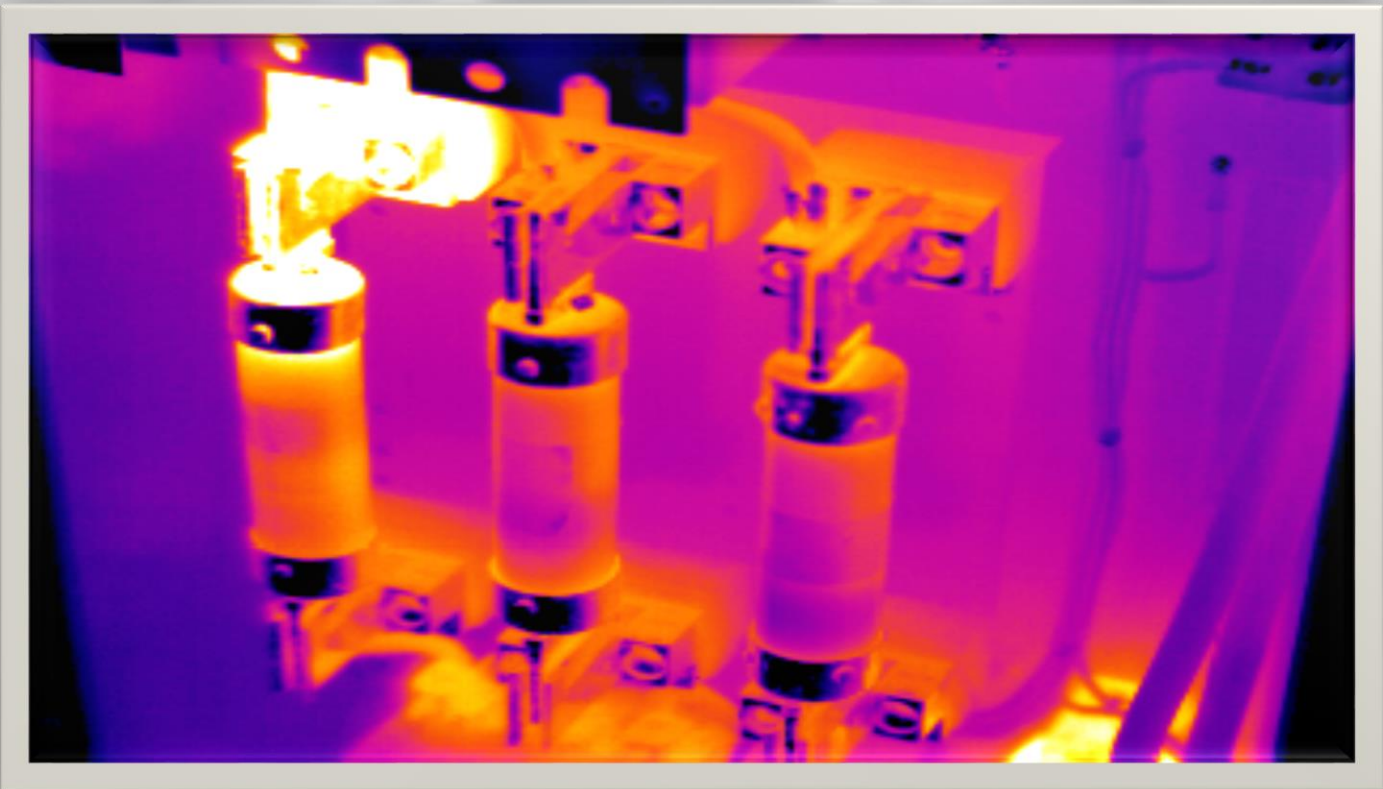
Produces Heat



Heat is wasted energy

Poor Electrical Connection lower
Electrical Efficiency





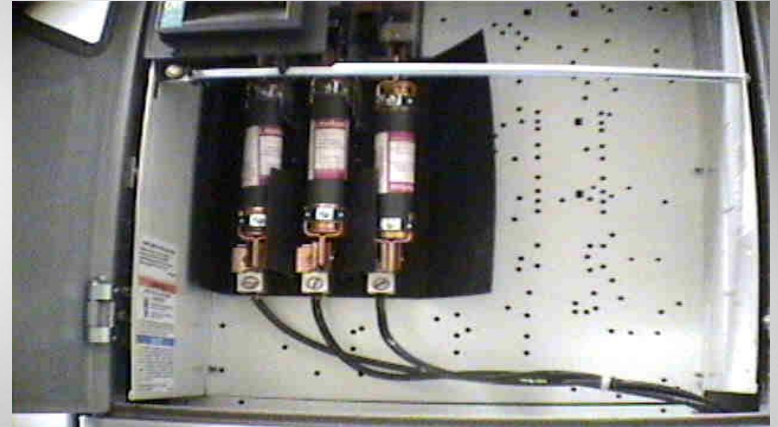
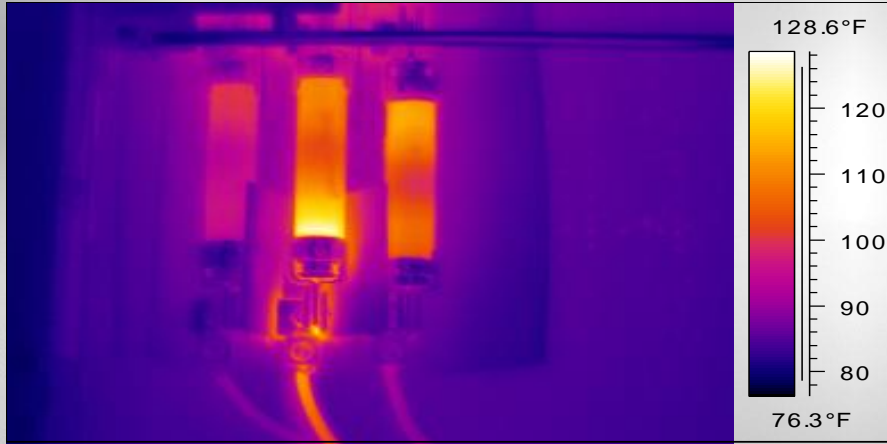
Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.



The World's Sixth Sense™

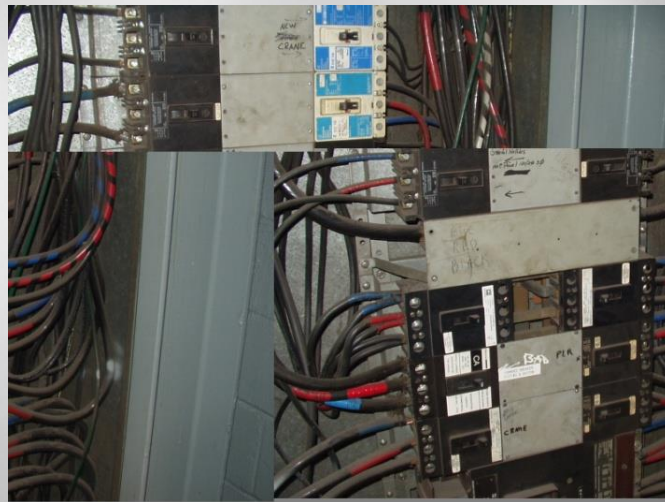
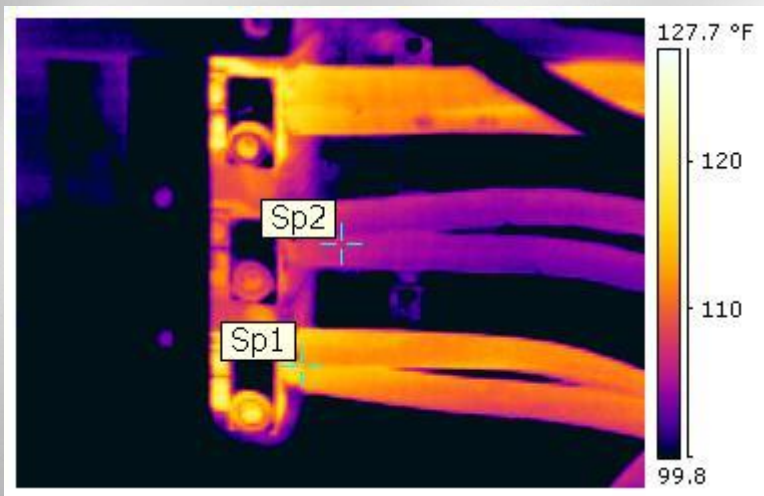
Fuses / Clips



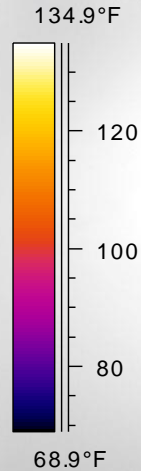
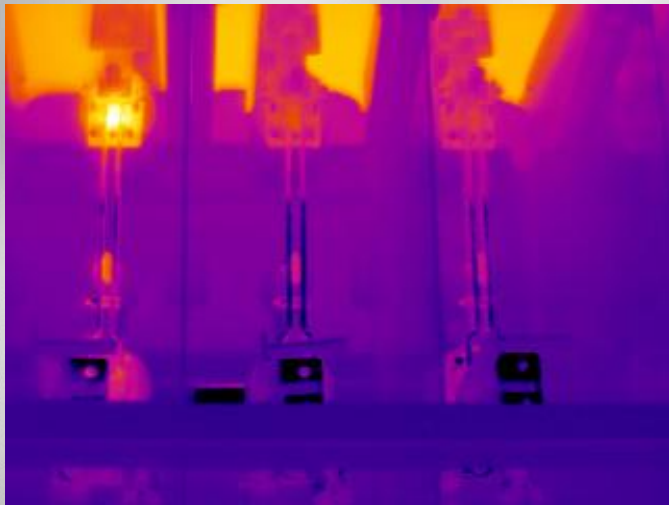
Circuit Breaker



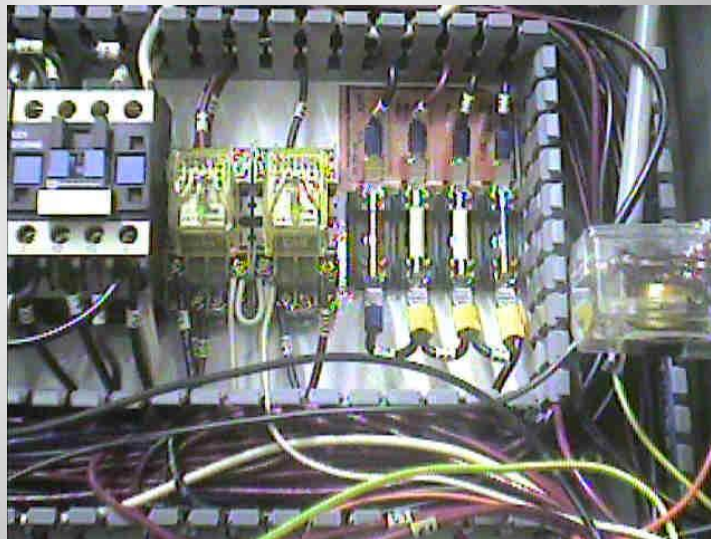
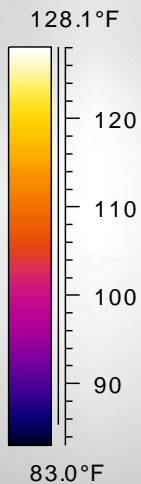
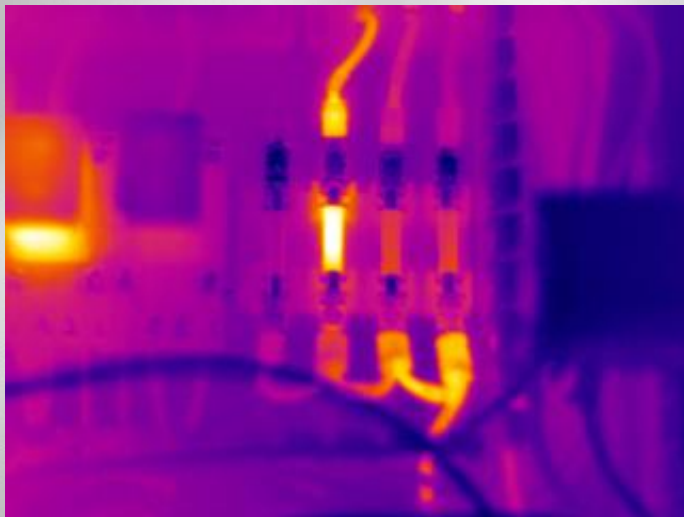
Unbalanced Loads



Medium Voltage Switch



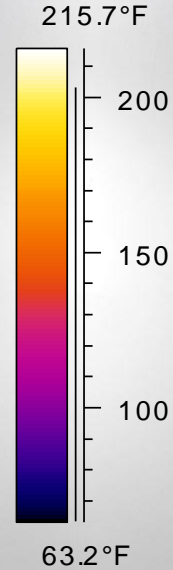
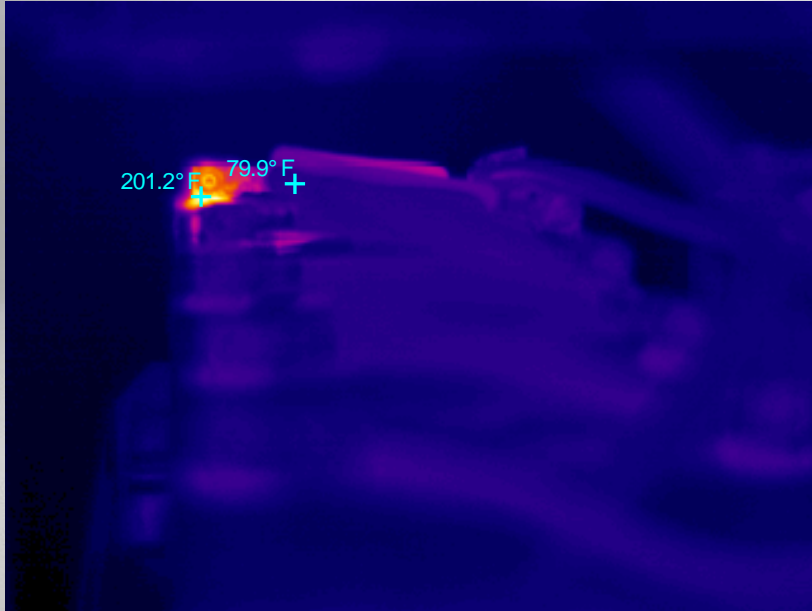
Control Panels



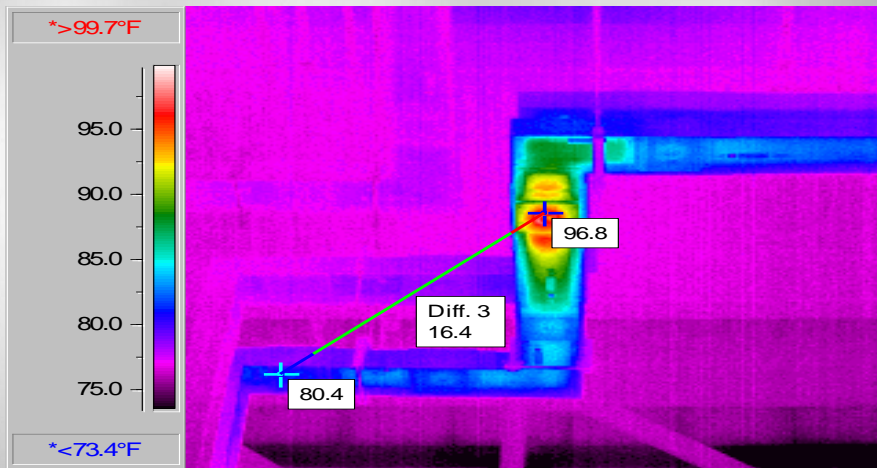
Circuit Breakers



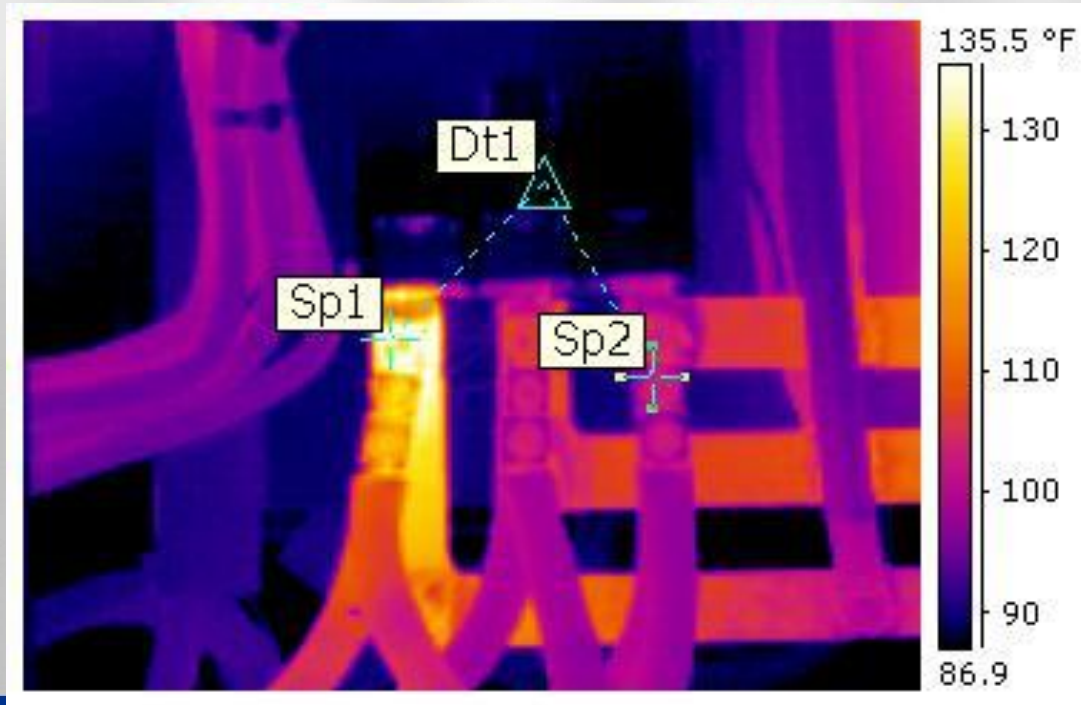
Batteries



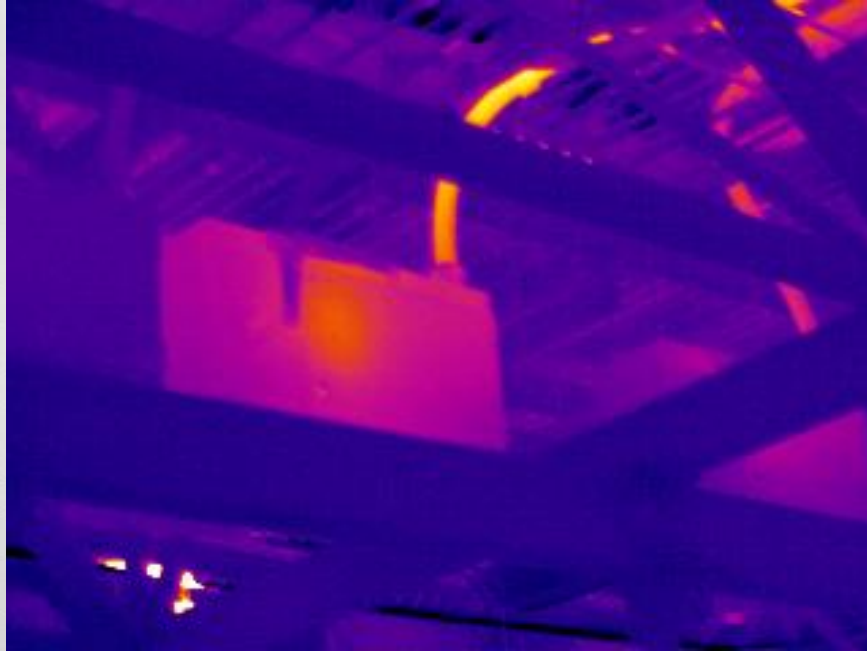
Bus Ducts



Bus Bars



Bus Switches



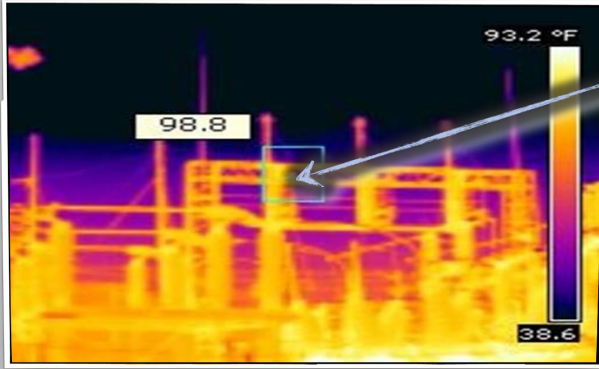
Outdoor Electrical Switch Disconnect



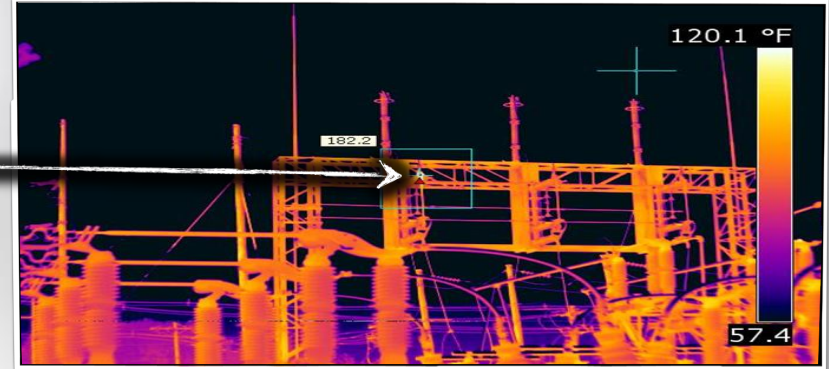
Outdoor Electrical



Accuracy At A Safe Distance

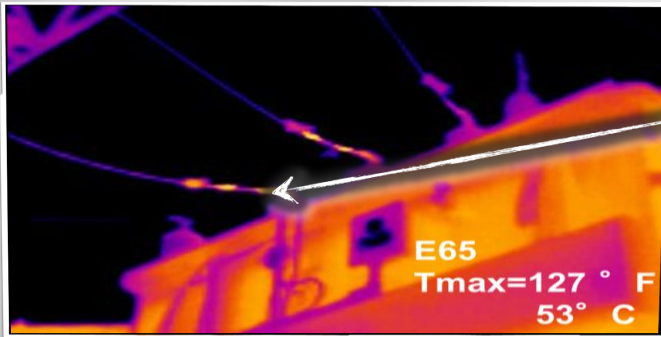


19,600 pixels



307,200 pixels

98°F
↕
182°F



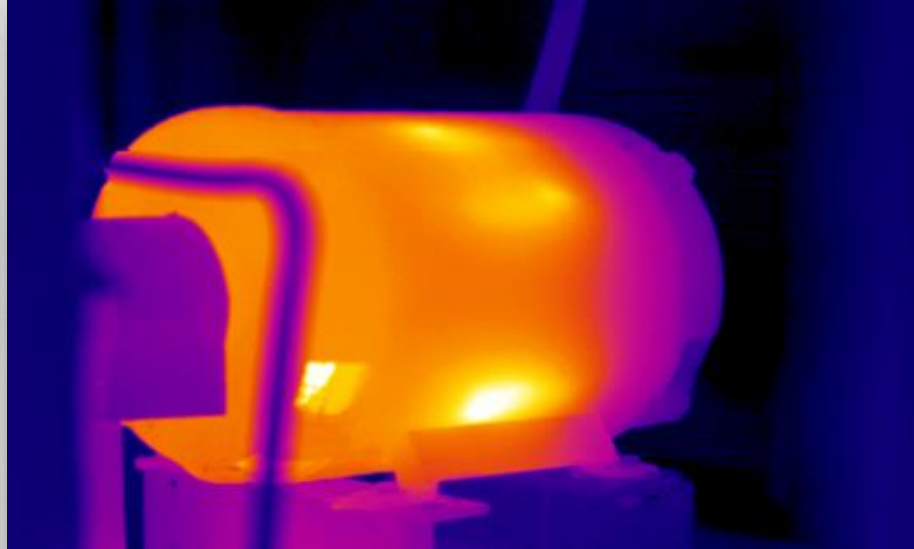
127°F
↕
280°F

MECHANICAL SYSTEMS

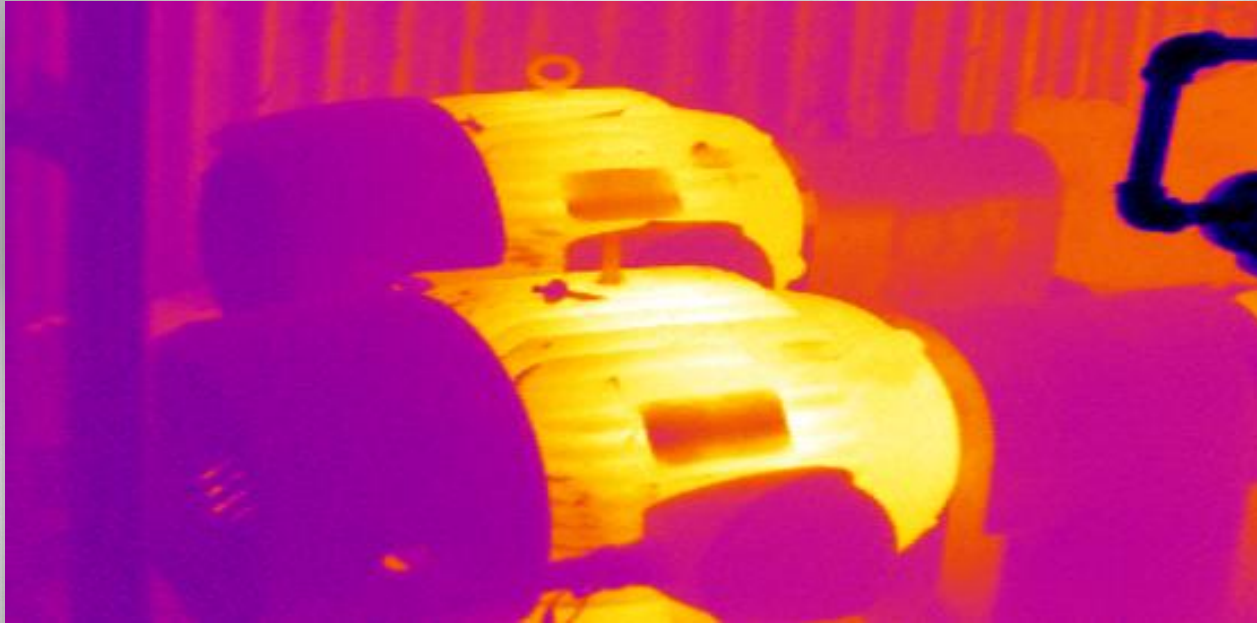
MOTORS AND BEARINGS

Mechanical Systems

- Pumps
- Motors
- Conveyors
- Gear boxes
- Drive shafts
- Belts and pulleys
- Bearings



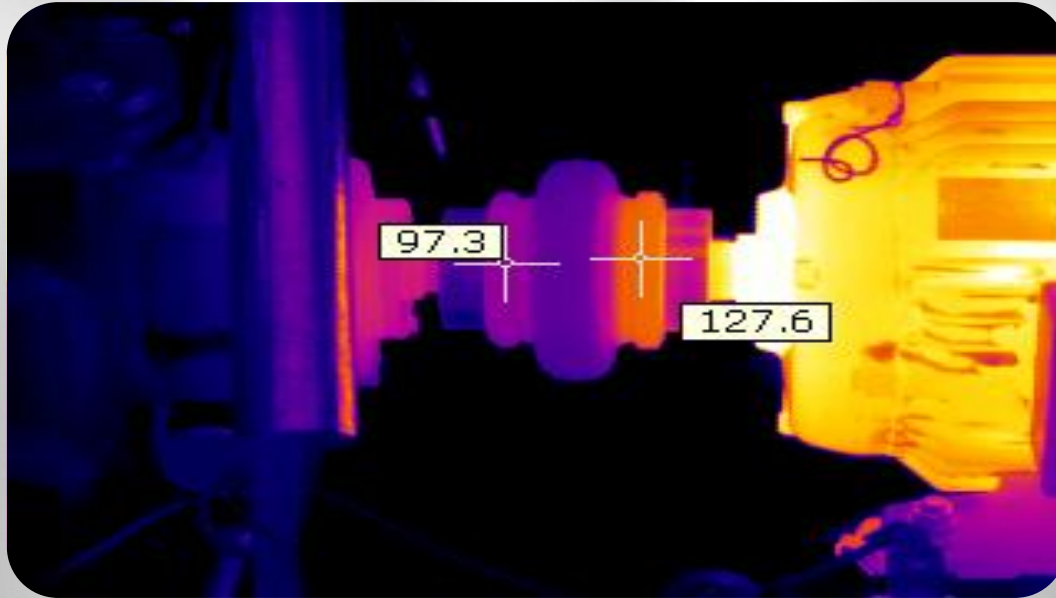
Mechanical Systems



Overheated Motors

A typical motor operating at 10°C over design cuts the life of a motor in half.

Mechanical Systems



Misaligned coupling show a 30°F temperature rise.

What NEW in thermal imaging?

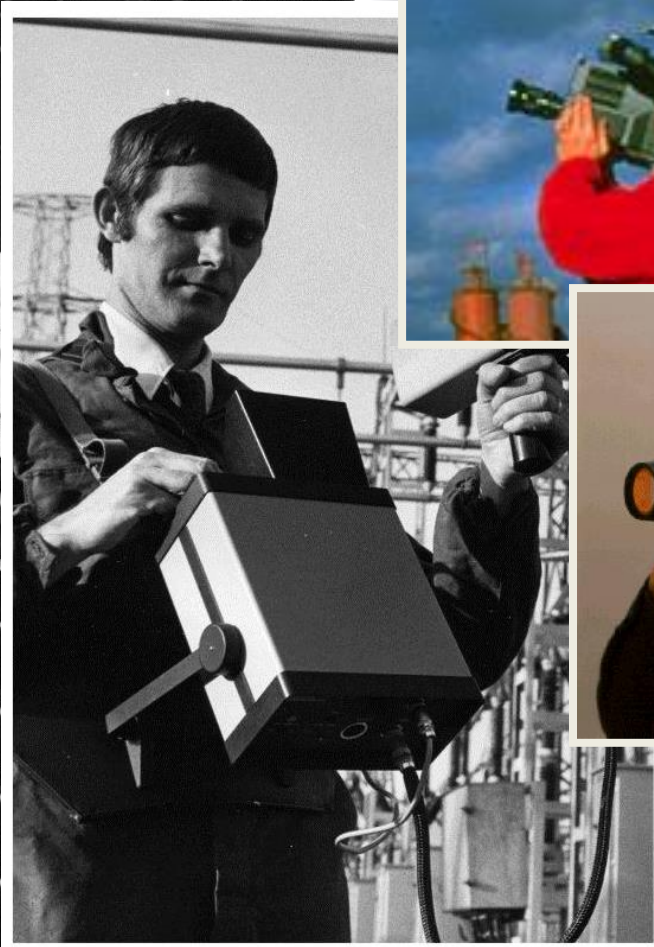
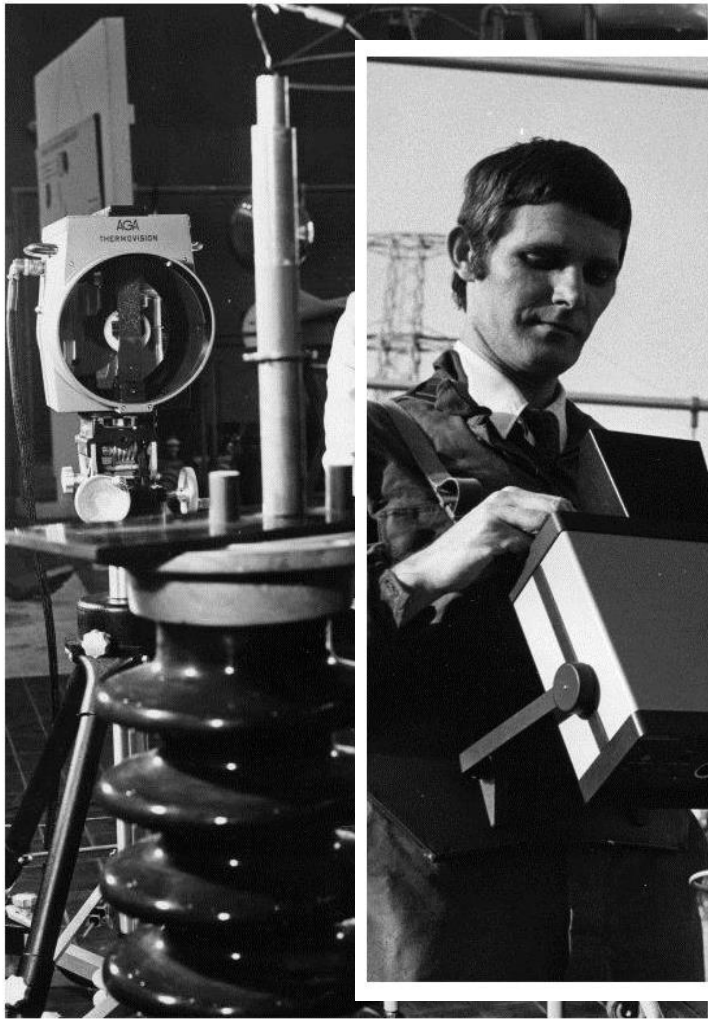


Proprietary - Company Confidential ©2014 FLIR Systems Inc.

Information and equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.



The World's Sixth Sense™





Cost of Technology



FLIR's TG165
Imaging IR Thermometer

FLIR C2

Compact Thermal Imaging System



Most Comprehensive Suite of Cameras



FLIR TG165
Imaging Thermometer

FLIR EX Series



FLIR EXX Series



FLIR T4XX Series

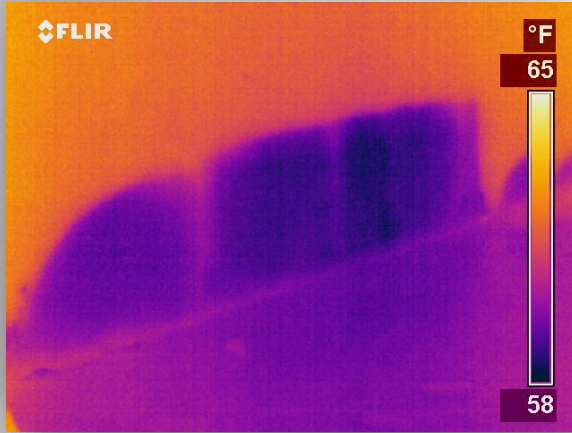


FLIR T6XX Series



FLIR C2
Thermal Imaging Camera

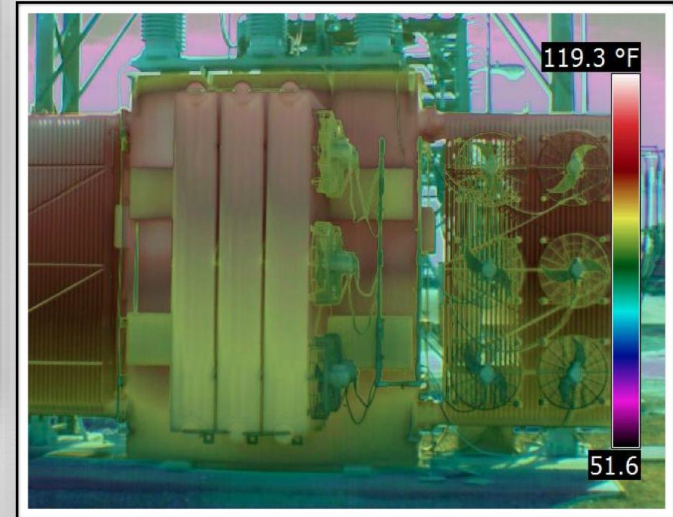
Image Quality and Enhancements



Thermal Imager

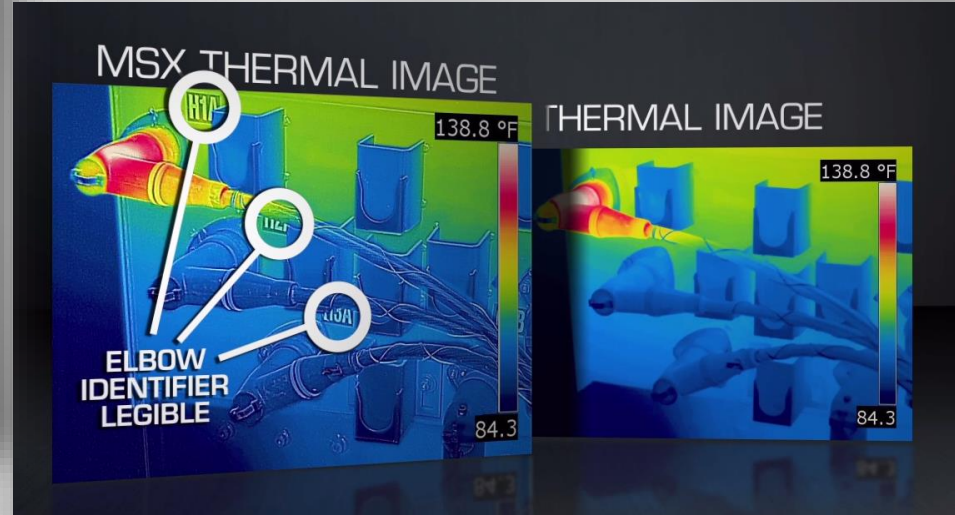
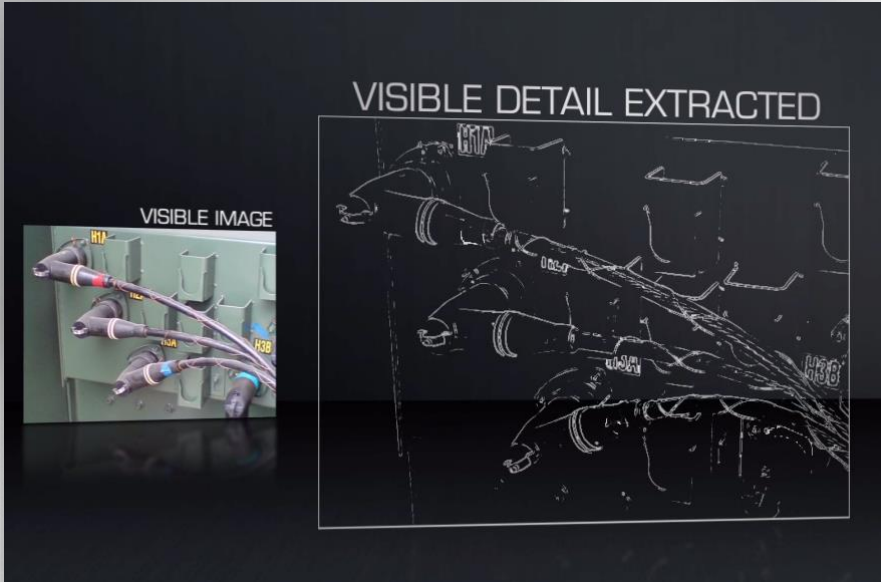


Picture in Picture



Thermal Blending

MSX on all FLIR Cameras





ULTRAMAX – The Ultimate Resolution

- Quadruples the pixel count
- 50% less noise

*Transforms
640x480 images
into eye-popping
1280x960 images*



FLIR Tools Mobile Ecosystem



FLIR IR CAMERA LINE UP

Which one is right for you?

Choosing the Right Camera

Lower Resolution
Simple to use
Point-n-Shoot

Mid-Range Resolution
Addition Function
Manual Focus
Connectivity – WIFI, Bluetooth

High Resolution
Advanced Features
Autofocus
Real-Time Recording

Troubleshooters

Basic PM

Advanced PM

Pro-Series

\$349/\$699

\$10K

\$39,950



TG165/C2



Ex-Series



Exx-Series



T4xx Series



T6xx Series

FLIR's TG165

Imaging IR Thermometer

- **80 x 60 array (4800 pixels)**
- 24:1 spot ratio IR Thermometer
- Saves generic bmp (faster)
- Dual Laser
- Extremely fast boot up
- Fits in a pocket
- Rugged: 6.5' drop, water resistant
- **2/10 warranty**



\$349



TA13 Protective Case
(accessory)

FLIR C2

Compact Thermal Imaging System

\$699

Pocket Portable
Fully Radiometric
Enhanced Resolution with MSX
Touchscreen



FLIR EX Series Platform

Small, light, powerful

The perfect troubleshooting tool

The FLIR **EX Series** cameras include:

- Radiometric JPEG image storage
- Fixed Focus (focus free)
- 2.8" Color LCD
- -4°F to 482°F Temperature Range
- MSX



FLIR EX Series Platform

Small, light, powerful
The perfect troubleshooting tool

80x60
E4
\$995

120x90
E5
\$1,495

160x120
E6
\$2,495

320x240
E8
\$3,995



FLIR EXX Series Platform

*Wi-Fi, Video & Touchscreen
The well connected Thermal Imager*



The FLIR **EXX Series** cameras include:

- Fine focus capability, lens options
- 3.5" Color LCD
- -4°F to 1202°F Temperature Range
- Advanced analysis modes
- Meterlink

FLIR EXX Series Platform

*Wi-Fi, Video & Touchscreen
The well connected Thermal Imager*



160x120

E40

\$3,495

240x180

E50

\$5,995

320x240

E60

\$6,995

FLIR T4XX/6XX Series Platform

The Professional Series



The FLIR **EXX Series** cameras include:

- Best Ergonomics
- Highest IR Resolution (UltraMax)
- Advanced Optics
- Multiple focus options
- Sketch & GPS

What do *you* want in a meter?



Easy to use

High level accuracy

Tough and reliable

Ready for today



Designed for
a 6 ½ foot Drop



LIMITED
LIFETIME
WARRANTY



Customer Driven Features

LoZ



VFD Mode



Silicone Test Leads



FLIR Clamp Meter Suite

- Rugged FLIR Design
- 600V/1000V AC/DC multifunction
- Advanced Power Analysis and VFD Functions (CM83)
- High Powered Illumination
- Connectivity to tablets, smart phones, and FLIR cameras



FLIR Clamp Meters



CM174 - \$499.99

- IGM!
- Spot Temp Measurement
- Safety
- Productivity

FLIR Flex Clamps



CM57 - \$224.99

CM55 - \$199.99

- Stand alone FLEX clamp
- 3000 Amp AC Max Range
- Work Lights
- In Rush Current
- Bluetooth®, FLIR Tools Mobile for iOS® and Android®
- Data Recording
- Limited Lifetime Warranty

Accessory Flex Clamp

*Universal
Accessory*



Accessory Flex Clamp



TA74 – 18” \$179.99

TA72 - 10” \$159.99

- 3000 Amp AC Max Range
- Work Lights
- 3 meter drop
- Limited Lifetime Warranty
- Universal Accessory

FLIR Digital Multimeter Suite

- Rugged Design & Big Digit Display
- High Powered Illumination
- VFD and LoZ Modes
- Connectivity to tablets, smart phones, and FLIR Cameras



FLIR Systems

Thank You!