In the Matter of:

FLIR Systems, Inc.

vs.

Leak Surveys, Inc.

Roy Malmberg

January 15, 2015

MERRILL CORPORATION
LegaLink, Inc.
311 South Wacker Drive
Suite 300
Chicago, IL 60606
Phone: 312.386.2000
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UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

FLIR Systems, Inc.,	)	
	)	
Petitioner,	)	Trial No.
	)	IPR2014-00411
-vs-	)	
	)	U.S. Patent No.
LEAK SURVEYS, INC.,	)	8,426,813 B2
	)	U.S. Patent No.
Patent Owner.	)	8,193,496 B2
_____	)	

DEPOSITION OF ROY MALMBERG

THURSDAY, JANUARY 15, 2015

1:30 p.m.

REPORTED BY: ERIKA SJOQUIST, C.S.R., R.P.R., C.R.R.
C.S.R. No. 12350

DEPOSITION OF ROY MALMBERG, VOLUME 1, TAKEN AT 1:30 P.M., THURSDAY, JANUARY 15, 2015, AT 21 E. CARRILLO STREET, SUITE 190, SANTA BARBARA, CALIFORNIA, BEFORE ERIKA A. SJOQUIST, C.S.R., R.P.R., C.R.R., C.S.R. NO. 12350, CERTIFIED SHORTHAND REPORTER, IN AND FOR THE STATE OF CALIFORNIA.

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ALSO PRESENT: CHRISTIAN J. MARTINEZ, VIDEOGRAPHER

I N D E X

E X H I B I T S

INSTRUCTION NOT TO ANSWER: 37:11, 74:13, 75:14

SANTA BARBARA, CALIFORNIA

THURSDAY, JANUARY 15, 2015

1:30 P.M.

THE VIDEOGRAPHER: Good afternoon. This is the videotaped deposition of Roy Malmberg in a matter of FLIR Systems versus Leak Surveys. This case is pending in the United States Patent and Trademark Office before the Patent Trial and Appeal Board.

Today's date is Thursday, January 15, 2015. And the time on the video monitor is 1:31 p.m. The location is 21 East Carrillo Street, Suite 190, Santa Barbara, California.

The certified shorthand reporter is Erika Sjoquist. My name is Christian Martinez, a certified legal video specialist, and I represent Depo Vision located in Santa Barbara, California.

Would counsel and all present, please, introduce yourselves for the record and state whom you represent.

MR. VINNAKOTA: This is Rajkumar Vinnakota with the law firm of Skiermont Puckett, representing patent owner Leak Surveys, Incorporated.

MR. PUCKETT: Donald Puckett, also representing patent owner Leak Surveys.

MR. LEWIS: Chris Lewis with FLIR Systems.

MR. EMERSON: Russ Emerson, Haynes & Boone, for FLIR Systems.

MR. DeMILLE: Rickard DeMille, Brinks Gilson Lione, for FLIR Systems.

MR. GABRIC: Ralph Gabric, Brinks Gilson, on behalf of FLIR Systems and the witness.

THE VIDEOGRAPHER: Thank you.

Would the court reporter, please, swear in the witness.

COURT REPORTER: Raise your right hand for me, please.

Do you solemnly swear or affirm that the testimony you're about to give today will be the truth, the whole truth, and nothing but the truth?

THE WITNESS: I do.

COURT REPORTER: Thank you.

THE VIDEOGRAPHER: You may proceed.

ROY MALMBERG,

HAVING BEEN FIRST DULY SWORN BY THE REPORTER, WAS EXAMINED AND TESTIFIED AS FOLLOWS:

EXAMINATION

BY MR. VINNAKOTA:

Q Good afternoon, sir.

Can you please state your full legal name for the record?

A Roy Dale Malmberg.

Q Thank you. Can you, please, spell your last name for the record?

A M-A-L-M-B-E-R-G.

Q Have you ever did not deposed before?

A No.

Q This is your first deposition?

A Yes.

Q Since it's your first deposition, I'm going to go over some ground rules, which you may have already gone over with your counsel here, so bear with me for a couple seconds.

As you can see, that you are being videotaped and also there is a court reporter taking down every word that's being said.

You have an understanding of that; is that correct?

A Correct.

Q Because the court reporter is taking every word that you are saying, it's very hard for the court reporter to take any type of verbal cues, like nodding or kind of a shaking of the head.

During this process, when I ask questions and you want to answer, can you please go ahead and make sure that you verbalize your answer in whatever form so the court reporter can take that?

Do you understand that?

A Yes.

Q And since again this is your first deposition, I am going to go over some other ground rules, which I'm supposed to go over with respect to the procedure and also the proceedings that we're in; one being that this is not going to be a marathon session. So if you want -- I usually break every hour on the hour. It's how I usually go, but if you want to take a break at any time, just let me know. Let's just finish up that question, and we can take that break.

Is that okay with you?

A Yes.

Q But I have to caution you, however, though,

that during the breaks, in these proceedings, you are not allowed to talk about the substance of what you are being cross-examined or what you may be cross-examined with any of the lawyers that are representing you.

Do you understand that?

A Yes.

Q So to be fair, when you come back from the break, I'm going to have to ask you that question, if you spoke to any attorney regarding the substance that you just testified on or you may be testifying on. And so we are going to be asking that question right after each break.

Okay?

A (Indicating).

Q And also, if for some reason you have spoken to the attorney, you have to truthfully tell me that.

Do you understand that?

A Yes.

Q The final point, also, I would just like to make is that during the process of this deposition, when I ask a question, your lawyer will say stuff occasionally, objecting to maybe the form of the question or instructing you not, the witness, for privilege, answer.

Do you understand that?

A Yes.

Q Unless the -- your attorney specifically instructs you not to answer, you still have to complete the answer regardless of what objection he may put into the record.

Do you understand that?

A Say that again.

Q Unless your attorney specifically instructs you not to answer, you still have to finish completing the answer to any question I ask regardless of what objection he may say unless he specifically tells you not to answer.

Do you understand that?

A Yes.

Q How did you prepare for this deposition?

A I reviewed the document, the brochure for the Merlin camera.

Q Is there anything else you reviewed?

A No.

Q And when did you do -- when did you review this document, this Merlin brochure you referred to?

A February 2013. A year ago, approximately.

Q Let me rephrase the question.

You -- my question was, first, did you review anything for preparation of this deposition?

MR. GABRIC: Let me just --

MR. VINNAKOTA: I -- I'm going to --

MR. GABRIC: Let me help you out. There's a difference between declaration and deposition. This is your deposition.

MR. VINNAKOTA: Right. Counsel, I'll get it. I'll straighten it out. You don't have to coach him.

BY MR. VINNAKOTA:

Q So, my question was, in preparation for this deposition today, what did you do to prepare for that?

A I sat with my legal counsel.

Q And I don't want any of the communications. That's privileged.

When did you sit with your legal counsel?

A Tuesday and yesterday afternoon, Wednesday.

Q Of this week?

A Yes.

Q And approximately, how long did you sit with your legal counsel?

A Two sessions. Probably a total of 3 hours.

Q Three hours each session or 3 hours in combination of both sessions?

A Combination of both sessions.

Q And in those sessions, my question is, did you review any documents?

A Yes.

Q And what did you review?

A We reviewed the brochure, the Merlin brochure.

Q Is there anything else you reviewed in preparation for this deposition?

A No.

Q So I'm going to go ahead, for housekeeping sake, introduce what's going to be marked as Malmberg Deposition Exhibit 1, and this is a deposition notice.

(Exhibit 1 marked for identification.)

Have you seen this document?

A No.

Q Can you, please, look through it?

Upon your review, your testimony is you still have never seen this document?

A That's correct.

Q And just for the record, I will note the Notice of Deposition was stated that your deposition was going to take place Friday -- Friday, January 16th, at 9:00 a.m. of this year. By stipulation of parties, we moved your deposition to this time.

Were you made aware of that?

A Yes.

Q When were you made aware of that?

A Wednesday. Wednesday afternoon.

Q Was that change in the deposition time something that you wanted?

A Yes. I have a commitment tomorrow for a field test, and my presence was required out there in the field.

Q When did you become aware that you had a field test that you have to conduct?

A I was asked if I could participate Tuesday by managers at FLIR.

Q I'm also going to hand you a series of documents, and we will go through it individual, but it's easier if I just go ahead and hand it to you in one setting. The first is, uhm... well, what I'm going to mark as Malmberg Exhibit 2.

(Exhibit 2 marked for identification.)

And I'm going to also going to hand you what's going to be marked as Malmberg Exhibit 3 to this deposition.

(Exhibit 3 marked for identification.)

And I'm also going to hand you what's being marked as Malmberg Exhibit 4.

(Exhibit 4 marked for identification.)

And finally, I am going to hand you what's been marked as Malmberg Exhibit 5.

(Exhibit 5 marked for identification.)

And I'm going to go through these one at a time, so bear with me.

Okay. So looking at Malmberg Exhibit 2, take a couple seconds to look through that. I will represent is a signed declaration by you. What I'd like first is confirmation that you did provide a declaration. And you can turn to the page Exhibit 10160005. It's dated February 6, 2014.

Can you confirm that you actually signed this declaration?

A Yes.

Q Can you -- without going to the attachments yet, can you check to make sure this is the entirety of the declaration that you had signed on February 6, 2014? And we are still on Malmberg Exhibit 2. Sorry.

A Yes.

Q Now, attached to Malmberg Exhibit 2, uhm, I believe are two attachments, an Attachment A and Attachment B. I'll represent Attachment A is --

Well, I believe from your declaration, you called this the Merlin brochure; is that correct?

A That's correct.

Q And Attachment B, again from your declaration, you called this the Merlin User Guide; is that correct?

A That's correct.

Q Again, take a couple minutes. I want to make sure we have the entirety of what you consider Attachment A and Attachment B.

And my question is, can you confirm that the entirety of Attachment A and B is included in Malmberg Deposition Exhibit 2?

A That looks to be a complete copy of the users guide and the Merlin brochure.

Q Thank you.

Can you now turn to Malmberg Deposition Exhibit 3?

And at some point in these proceedings, did you sign a second declaration in these proceedings?

A Yes.

Q And if you turn to page 4 of this declaration,

it's dated October 2, 2014.

Do you see that?

A Yes.

Q Is this the second declaration you executed in these proceedings after you reviewed the contents, sir?

A Yes.

Q Are you aware of signing any other declarations in these proceedings?

MR. GABRIC: Object to form.

THE WITNESS: Yes. There's -- Exhibit 5 is another declaration and 4. 4 and 5 are two more declarations.

BY MR. VINNAKOTA:

Q Okay. So, let's look at Exhibit 4, please. And if you turn to page 5, it's dated October 16, 2014; is that correct?

A Correct.

Q Who put the "one six" in there?

A I don't know.

Q Is that your signature?

A Yes.

Q But did you put the "one six"?

A I don't recall.

Q Do you recall when you signed this declaration then?

A Not specifically.

Q Okay. And so, this is a additional declaration that you provided, is that correct, that you believe you did?

A Correct.

Q But you don't know when you actually dated it; is that correct?

A That's correct.

Q Okay. Let's go back to Exhibit 2 and 3 real quick.

In Exhibit 2, you see the February 6, 2014, date on page 5?

A I'm sorry. Say that --

Q On Exhibit 2, if you turn to page 5 --

A Page 5.

Q -- there's a February 6, 2014 date.

Do you see that?

A Oh, sorry. I'm on the wrong one. February 6th, yes.

Q Do you recall seeing the "6" in that line before you signed it?

A Not specifically.

Q And then also, if you turn to deposition Exhibit 3, on page 4 --

A Yes.

Q -- where it says October 2, 2014 --
A Yes.
Q -- do you recall seeing that "2" in October 2nd before you signed it?
A Not specifically, no.
Q Now, let's turn to deposition Exhibit 5.
Do you see the, on page 5, February 6, 2014, date?
A Yes.
Q On February 6, 2014, did you only sign one declaration in these proceedings?
A I don't recall.
Q Do you think you may have signed two declarations?
A I don't recall.
Q We'll get back to that one. Let's go back to deposition Exhibit 2. Let me strike that. Let's turn back to deposition Exhibit 3.
On deposition Exhibit 3, there's also two, I'm sorry, three attachments.
Am I correct on that?
A Correct.
Q And when you executed this declaration, did you have three attachments?
A I don't recall.

Q Do you recall whether or not you executed a declaration that talked about three attachments?

A No.

Q So when you signed this declaration, that's dated October 2nd, 2014, did you know there were any attachments to it?

A No.

Q So when you executed this declaration, dated October 2, 2014, were you just provided a declaration with no attachments?

A To the best of my recollection, yes.

Q Let's go to deposition Exhibit Number 4.

Deposition Exhibit Number 4, there are four attachments.

Do you see that?

A Yes.

Q When you executed this declaration that -- you testified earlier you are not sure who put the "16" in October 16, 2014.

Did you personally attach these -- let me strike that. Let me rephrase the question.

This declaration that's purportedly executed on October 16, 2014, when you executed this declaration, did you see these attachments attached to that declaration?

A No.

Q Let's go back to deposition Exhibit 3, please. And specifically, can you turn to Attachment B? Seems to be a web printout page.

Do you agree with me?

A Yes.

Q Did you print out this web page?

A No.

Q Have you ever seen this?

A No.

Q Can we turn to Attachment C, please? Seems to be another printout of a web page.

Do you agree with me?

A Yes.

Q Did you print out this web page?

A No.

Q Have you ever seen it before?

A No.

Q Okay. Let's turn to deposition Exhibit Number 2, please, paragraph 1.

For the record, who do you currently work for right now?

A FLIR.

Q And by FLIR, is there -- is that the common name for the company? What's the full legal name of the

company that you are aware of?

A FLIR Systems, Incorporated.

Q Is that the parent corporation or a subsidiary that you work for? A division?

A It's the parent company.

Q Do you work for any division in that company?

A I work for the customer -- I work on the surveillance side for the consumer electronics or consumer systems.

Q But it's not like a subsidiary. It's still --

A It's FLIR as a parent company. There's no -- it's not a subsidiary.

Q Paragraph 1, it says you had previously worked for a company called Indigo Systems Corporation; is that correct?

A That's correct.

Q When did you start working at Indigo Systems Corporation?

A June of 2000.

Q And then it says you worked there until it -- it being Indigo -- was acquired by FLIR Systems in 2004; is that correct?

A That's correct.

Q Do you recall when in 2004 FLIR Systems acquired Indigo?

A No.

Q When you worked with Indigo from 2000 to sometime in 2004, who did you report to as a supervisor?

A Jeff Frank.

Q And who is Jeff Frank?

A He was director of sales and marketing at Indigo Systems.

Q And throughout your approximate 4-year employment at Indigo Systems, did you always report to Jeff Frank?

A He was the lead supervisor for sales marketing, yes.

Q Was there anyone else you reported to during that time frame?

A I was on a team of people that -- we were all in the sales and marketing team.

Q Who else was on that team?

A Susan Petronio, Stan Laband, and Rudy Machuca joined us 2001.

Q Susan Petronio, was she there before or after you joined?

A Before.

Q Stan Laband, was he in that group before or after you joined?

A Before.

Q And you just testified Rudy... can you spell his last name, if you know it, for the record?

A Yeah, Machuca, M-A-C-H-U-C-A.

Q And your testimony is he started sometime in 2001?

A Yes.

Q Do you recall what point in 2001 he started?

A Not specifically.

Q And to be clear, where I got this question was, I asked who was your direct supervisor at the time -- the 4-year approximate time you were at Indigo, and you mentioned Jeff Frank.

A Yes.

Q Any of these other three individuals ever become your supervisor?

A No.

Q Did you supervise them?

A No.

Q So all four of you just reported directly to Jeff Frank; is that correct?

A Yes.

Q And who did Jeff Frank report to?

A President of Indigo at the time. I... I don't recall now.

Q Who is -- let me ask if you know who some of

these... do you know who a Tim Fitzgibbons is?

A Tim, yes. Tim Fitzgibbons.

Q Who is Mr. Fitzgibbons?

A He was the -- I don't know if his title is president or chief executive officer.

Q Is that who Jeff Frank reported to?

A Yes.

Q Do you know who a Bill Parrish is?

A Bill Parrish, yes, was on the executive management team.

Q Did Mr. Fitzgibbons report to Mr. Parrish?

A No.

Q I'm just trying to understand if you have any knowledge of -- well, did Mr. Frank report to Mr. Parrish?

MR. GABRIC: Objection. Foundation.

BY MR. VINNAKOTA:

Q That you have any personal knowledge of?

A I don't -- no, I don't know.

Q Was there anyone else while you were still at Indigo that you worked with in that 4-year time span?

A Yes.

Q Who else?

A I was in sales and marketing. So we interfaced with all portions of the organization.

Q What other portions of the organizations did you interface with?

A The engineering team, manufacturing.

Q Do you recall who in the engineering team you interfaced with?

A I would have to have an entire list of the company. It was -- there was probably -- we were 75 strong in 2000.

Q Did you ever interface with Austin Richards?

A Yes.

Q And was Mr. Richards or Dr. Richards, I think, I believe, part of the engineering team or manufacturing or sales and marketing?

A He was like a chief technologist or maybe senior scientist. I don't know what his exact title was.

Q Do you recall what group he was primarily in? What group he functioned in?

A No, not specifically.

Q Do you recall any names from individuals at Indigo in manufacturing you interfaced with?

A James Ursettie was on the team in manufacturing.

Q Can you spell his last name for the record, please? Can you spell his last name for the record?

A Maybe U-R-S-E-T-T-I-E. That's real close.
Q Anyone else you can recall?
A Not specifically.
Q So let's turn to paragraph 2 of deposition Exhibit Number 2, shall we. It says:
"At Indigo, I held the titles of sales engineer and then sales manager."
See that?
A Yes.
Q When did that title change happen?
A I don't specifically recall.
Q Did it happen closer to the time FLIR acquired Indigo or would that help recall your memory?
A No. I just -- I don't recall specifically. It was a -- it was a promotion or a title change to reflect added responsibility and experience within the company, but I don't remember exactly when that happened.
Q The next sentence starts off with, "In that role..."
Do you see that?
A Yes.
Q Which role are you referring to?
A In the sales manager role.
Q So, the role doesn't talk about your responsibilities as sales engineer; is that correct?

A You know, those -- those two blended together. We were a very small team. And so, the lines was -- the line of demarcation within one job to another was -- the mantra there was nobody ever said, "That's not my job." That was -- that was what we were -- that was the mantra. We were still considered to be a small startup, and nobody ever said, "That's not my job."

Q What are the -- just like to get the record straight because the rest of that sentence, after "In that role," you list several duties.

Do you see that?

A Yes.

Q Do those duties include both roles as a sales manager and sales engineer or just sales manager?

A No. Both. They blended in together.

Q Okay. Can you tell me which ones are primarily as a sales engineer?

A The sales channel would have been a sales manager. Testing and evaluation of thermal camera systems was more of an engineering function. Trade shows was the sales manager. Pool assets sort of blends to both because there's a technical aspect of testing the systems, ensuring they were correct. And the sales manager was the -- in support of the sales cycle. And generally promoting the sales of products, I guess both

of those -- both of those functions as a test engineer or sales engineer and a sales manager both in support the sale of products.

Q And completing the sentence, it says:

"...including the Merlin and Phoenix thermal imaging cameras."

Do you see that?

A Yes.

Q What are the Phoenix thermal imaging camera?

A Phoenix was a higher powered version of the same style camera, large format; at the time was considered 640 x 480 as opposed to 320 -- 32 -- 30 -- let's see. 320 x 240 or 320 x 256. The Merlin had several different variants, and the resolutions were different for some of the cameras, but the Phoenix was the higher speed, more expensive of the two.

Q Do you know which came first in the development standpoint?

A The Merlin was first.

Q Do you know when Phoenix came online in the development standpoint?

A No, not specifically.

Q And when you mentioned the word, uhm, large format.

What do you mean by large format?

A In our world, a mega pixel camera is 640 x 480 as opposed to a 2 mega pixel camera. So, that was -- for the thermal industry, that was a large format camera.

Q Going back to some of the job duties you have, what do you mean by "supporting the outside sales channel"?

A The preparation of cameras for demonstrations would include testing a camera to make sure that it operated and that it had all the cables associated with it, so that you could send it out to a customer or a sales rep, and he could do a demonstration with the camera.

Q And you may have just answered this question, but what is a sales channel?

A That's the outside representative; our outward face to the customer.

Q And was part of your job duty to interface with these sales representatives?

A Yes.

Q Do you know who a Jeff Leake, L-E-A-K-E is?

A Yes.

Q Who is Jeff Leake?

A He was a sales representative that was responsible for -- lived in Texas, covered the Texas

area, Oklahoma, had a geographic territory.

Q Was he the sales representative for Indigo?

A They were -- they were not Indigo employees. They were contract employees of their own. So, we -- the business relationship, he was a member of a group called IRCameras.com.

Q So is your testimony, Indigo distributed Indigo cameras through a company called IR Cameras?

A They were a consortium of outside sales reps, yes.

Q The next duty that you have is testing and evaluation of thermal camera systems.

Do you see that?

A Yes.

Q And you mentioned earlier that's probably more of a sales engineer function than a sales manager; is that correct?

A Correct.

Q What kind of testing were you personally involved in?

A That would include ensuring that the camera operated; that you could turn it on and making sure that everything was -- everything was there to make the camera operate correctly.

Q And is this a already-built camera?

A Yes.

Q Were you involved in any of testing of any development cameras?

A I don't recall specifically.

Q And then you have "and evaluation."

What do you mean by "evaluation"?

A Just to make sure that the camera operated correctly, so that if you pushed a specific function, that the camera responded correctly and that the -- the data that you were recording was correctly recorded.

Q And what were you testing, evaluating against? Was there some protocol that you had?

A No. It's a subjective thing to make sure that it is imaging correctly.

Q Were there other individuals in your group that did the testing and evaluation?

A Yes.

Q And if it's a subjective evaluation, how did you know you were consistent?

A It's a -- it's subjective. So, you look at the image, and it does the -- does it have any image artifacts in it? Does it have a good span? Does it have good contrast in the image?

Q And are you testing and evaluating every camera coming off the manufacturing line?

A No.

Q Which cameras are you testing and evaluating?

A Cameras that were in the demo pool that would need to go out to the outside world.

Q So, let's talk about the next one, okay, where you talk about the -- we'll skip trade shows for a second, but in support of sales cycle and supervise Indigo's pool of demo assets, do you see that?

A Yes.

Q So, the only -- well, let me ask you this. What does "demo assets" mean?

A Demo asset is a camera that we -- we capitalize a camera, and we have it set so that if somebody requests a demo of a camera, we send it to them.

Q And so, those were the only cameras you tested and evaluated; is that correct?

MR. GABRIC: Objection. Form.

THE WITNESS: Yes. I did not -- tested only the cameras in the demo pool that were used for demonstrations to the outside world.

BY MR. VINNAKOTA:

Q So you never tested a camera that was actually bought by a customer perhaps; is that correct?

A Correct.

Q And going up one, where it says "Attending

Trade Shows," let's go back to that, do you recall what some of the trade shows you went to were?

A Yeah. There was only one main trade show for Indigo Systems at that time, was the SPIE conference. That was the main.

Q And because, again, we are doing a transcript, I think I know it and you know it.

Can you put for the record what the acronym stands for, what you just said?

A Oh. It's photonics. It's a society of photonics and -- gosh. I don't know what the acronym stands. It's SPIE. It's the SPIE conference.

Q Why don't you spell the acronym, how is that?

A S-P-I-E. It's a photonic society.

Q So, in the 2000 to 2000 (sic) time frame with Indigo, was that the only conference that you are aware of that -- let me strike all that.

In the 2000 to 2000 (sic) time frame, when you are at Indigo, is that the only trade show that you are aware of that you went to?

A Yes.

Q Were there any other trade shows that Indigo went to or someone in your group went to that you are aware of that you didn't personally attend?

A I don't recall.

Q Are there now additional trade shows that you are aware of now that you are working at FLIR?

A Oh, yes.

Q Can you list some of those other trade shows?

A CES last week in Las Vegas. That's one, one prime example.

Q Any other trade shows?

A Yes. We attend -- the list is like 500 strong. There's trade shows in numerous markets, numerous vertical markets we attend.

Q Does FLIR put on any trade shows?

A No. We attend the trade show as a conference attendee or we pay money and we set up a booth.

Q What do you mean by "generally promoting sales of the products"?

A That's the -- the aspect of the sales manager is to have an outward facing posture for prospective customers. So, answering telephones, picking up phone calls from somebody, and then routing them and helping them.

Q And when you just testified to routing them, where would you route them to?

A Other technical resources within the company that, if they are -- their questions were beyond my technical expertise.

Q Do you know why you signed this declaration? Let me strike that, first of all.

Did you prepare this declaration?

MR. GABRIC: Objection to form.

THE WITNESS: I provided the details of my specific work history and submitted that to legal counsel. To Chris.

BY MR. VINNAKOTA:

Q And I don't want any of your communications with your legal counsel. So I'm going to -- before he -- your counsel jumps in here, I'll caution you. This is going to be a series of probably, like, yes or nos, okay. That's the kinds of questions I'm going to ask, but what else did you provide -- let me ask you this.

Other than that, is there anything else you provided your legal counsel?

A No.

Q So the only thing you provided your legal counsel was your work history?

A Yes.

Q And so, after you provided that to your legal counsel, a declaration was prepared; is that correct?

A Yes.

Q And did you review that declaration?

A Yes.

Q And is it this declaration?

A Yes.

Q And so, which portion of this declaration, by paragraph number, is what you actually provided your legal counsel?

MR. GABRIC: Objection to form.

BY MR. VINNAKOTA:

Q Take your time. There's only nine paragraphs.

A I provided the specific details in paragraph 1 of my work history. I provided the job description. In paragraph 2, I provided the specifics of my duties and responsibilities. In 3 and 4, 5 and 6 -- all the rest of them refer to the two attachments, which are the users guide and the brochure.

Q And is it your testimony that prior to seeing this declaration, you did not provide the user guide or the brochure to any legal counsel; is that correct?

A That's correct.

Q Again, my question is, do you know why you signed this declaration?

MR. GABRIC: Object to form. You can answer that yes or no, and I don't want you revealing any communications with counsel regarding this declaration.

THE WITNESS: I still don't understand the question.

BY MR. VINNAKOTA:

Q Do you know why you signed this, this being Exhibit Number 2?

A Yes, to testify that the details included.

Q And how did legal counsel know to add a Merlin brochure and user guide if you didn't provide that information to them?

MR. GABRIC: I'll object to form. Calls for speculation. And instruct you not to answer.

(Witness instructed not to answer.)

BY MR. VINNAKOTA:

Q Are you going to take that instruction?

A Yes.

Q So let's turn to paragraph 6, shall we?

Paragraph 6, it's talking about what you've already confirmed as what is Attachment A; is that correct?

A Correct.

Q Now, when you executed this, this declaration, was Attachment A and B provided to you?

A Yes.

Q Had you seen what's -- and please feel free to turn to Attachment A -- prior to this declaration being

executed, Attachment A?

A Yes.

Q And what is your bases for saying that what's been marked as Attachment A is the exact copy of a Merlin brochure that you had previously seen?

A That was the -- it's the four -- four- or five-page, multifold brochure that we were representing the Merlin camera with.

Q Did you prepare that brochure?

A I participated in the development cycle of the brochure.

Q Who else participated in the development cycle of that brochure?

A That would have been Ilene Wrench on our staff in the marketing department, and Jeff Frank.

Q Anyone else?

A My colleagues in the sales cycle would have participated, in general, in the review, to ensure technical accuracy.

Q Anyone else you can name?

A Not specifically.

Q And describe in detail exactly what your participation was?

A I would have -- I wouldn't have commented on the colors or the -- the -- the creative aspect of it.

At my -- my -- my role would have been to review the technical accuracy of the specifications that -- that were written on here to help the marketing department.

Q And who came to you with any questions to review for accuracy?

A I don't understand the question.

Q Someone up -- did someone come to you and say, "Hey, Roy, we put this together. What do you think?"

How did that interface happen?

A It was just as a general. In the review cycle, it would be available to look over, but it wasn't my specific responsibility. It was just: Here's the brochure.

And since I had to represent it to the outside world, I would scan it and make sure the technical specifications and the minutia of the specs were correct.

Q And that review cycle was like a distribution list of individuals who are all participating?

A No, I don't think we were that formal. It was a small startup. And so, it was: Well, the brochure is ready, take a look.

Q Where did you look?

A I focused on the technical aspects of it.

Q Let me rephrase it. You just said, "Hey, the

brochure is ready, take a look."

What did you look at exactly?

A A draft copy of the brochure.

Q And how was that circulated to you?

A I don't recall.

Q Do you know how it was circulated to anyone on the development team, that brochure?

A No, I don't.

Q Then how do you know this is the iteration that was finalized?

A Based on the date time group from the printer.

Q What does that date time group mean to you?

A That's when we actually went to press with it. And so, if the -- if the printer printed it in January of '02, that would have been the -- that would have been the time frame. That would have been the date code, so we knew that we had the correct version of the camera that accurately reflected the product line.

Q Who is the printer?

A This company, local company called Buffalo Brothers.

Q Is Buffalo Brothers still in existence today?

A They are.

Q How do you know that?

A I checked with them.

Q When did you check with them?

A In preparation of the -- of the document to verify that the -- independently verify that they were printed in the January time frame.

Q Why did you check with them?

A To ensure that I was reflecting the specific brochure that was printed at that time frame.

Q And did you check with them before you signed this declaration or after you signed this declaration?

A No, before.

Q Okay. When precisely did you check with them?

A It would have been in the February 2000 -- 2013 time frame.

Q Do you mean '14? 2014?

A Yeah, sorry. I skipped a year there. Yes, it would have been in -- in preparation for signing the document. I checked with Buffalo Brothers to see if we could extract the document and the production run.

Q How come there's no mention of Buffalo Brothers anywhere in this declaration?

A I don't know.

Q In all those other declarations that you have in front of you, how come there's no mention of Buffalo Brothers in any of those declarations?

A It wasn't germane to what I was testifying to.

Q And how exactly did you verify from Buffalo Brothers what you just testified to?

A I contacted the remaining management structure of Buffalo Brothers, their production house, and I asked if we could get copies of the brochures that were printed and distributed during that time frame.

Q And did they send you some copies?

A No.

Q And who exactly at Buffalo Brothers was your contact person?

A I don't remember the gentleman's name. I would have to go look it back up in my records.

Q But it would be available in your records, right?

A I could find out who the gentlemen was. I would make a phone call to Buffalo Brothers to track down who it was.

Q So other than your apparent call to Buffalo Brothers that's not mentioned in any of your declarations, how else do you know that this is the exact brochure that you are testifying to?

A Because we prepared the brochure in anticipation of the SPIE conference in April.

Q But that's not mentioned in your first declaration; isn't that correct?

A I don't understand the question.

Q The deposition Exhibit Number 2, you don't mention that conference in that declaration; isn't that correct?

A No. In paragraph 6, the brochures were passed out at the SPIE trade shows.

Is that what you are referring to?

Q You are right. Let me strike all that.

So, what exactly did the gentleman at Buffalo Brothers tell you?

A He didn't have hard copies of the -- of the brochures anymore.

Q That's all he told you?

A That if we needed to go further into the records, if I wanted to verify specific runs of the brochures, that it would -- it would take him a lot of extra effort and time and money would be spent.

Q Was that extra effort conducted, to your opinion -- I'm sorry -- to your knowledge.

A No.

Q So, other than that, did you only make one call to Buffalo Brothers?

A No. I made two calls, I believe.

Q Okay.

A Maybe two calls.

Q So what you just testified to, was that on the first call or the second call?

A The second call was to verify or inquire how difficult it would be to go back and extract a hard copy of the brochure.

Q And did he tell you how much time and effort it would -- what that would consist of?

A No, not specifically.

Q And you made no effort to follow up on that; is that correct?

A Correct.

Q And for the record, you don't recall this person's name at Buffalo Records (sic) as you sit here today; is that correct?

A Not off the top of my head, no.

Q And you didn't think that was important to know coming into this deposition; isn't that correct?

MR. GABRIC: Objection to form.

THE WITNESS: That's correct. I verified that they printed the brochure in the 2002 time frame, and that's what I wanted to verify.

BY MR. VINNAKOTA:

Q And how, again, did the individual at Buffalo Brothers verify to you that they printed it in the 2002 time frame?

A He had billing invoices he could verify which production runs were made at a specific time.

Q And you don't include any of that billing invoices in any of your declarations; isn't that correct?

A That's correct.

Q Have you asked for those billing invoices?

A No.

Q Do you know if there would be any -- let me strike that.

When you -- after you had gone to the development cycles brochure and you put your input, do you know who gave the final green light on it?

A Jeff Frank and Ilene Wrench would have been the actual final signoff on the brochure.

Q And do you recall what Ilene Wrench's title was?

A She was marketing -- marketing specialist, I think is what the title was, but that was -- that was her purview. Her business was to prepare brochures, do the creative aspect of it. She wasn't a technical -- she wasn't a technical writer.

Q Do you have any knowledge of who contacted Buffalo Brothers?

A Ilene Wrench worked with the printer.

Q And what is your basis of having that personal knowledge?

A That could be because I know that was her job.

Q So let me ask the question again.

Do you have any actual bases to know that Ilene contacted Buffalo Brothers?

A No.

Q And so, you also don't have any knowledge of what Indigo may have been invoiced by Buffalo Brothers; isn't that correct?

A That's correct.

Q And you made no effort to go look for any invoices in Indigo System to verify what the Buffalo Brothers individual told you; isn't that correct?

A Correct.

MR. VINNAKOTA: How about we take a break?

THE VIDEOGRAPHER: Time is 2:27 p.m. We are off the record.

(Off the record.)

THE VIDEOGRAPHER: Time is 2:37 p.m. We are back on the record.

BY MR. VINNAKOTA:

Q Sir, before the break, I cautioned you that the

rules require that you don't speak to your counsel about the substance of any testimony.

Did you speak to your counsel about any of the substance of the testimony you just testified to?

A No.

Q Did you speak to your counsel about the substance of any testimony that might come up?

A No.

Q Going back to Buffalo Brothers, with respect to the individual you can't recall that you spoke to, approximately two times, prior to your testimony executing this declaration that's been marked as Exhibit 2 to this deposition, did that individual tell you precisely when Merlin brochures were printed?

A No.

Q What did that individual tell you?

A That it would cost time and money for him to go back through his records to extract specific data related to it. It's in his database, but it was hard to get to.

Q Did the individual tell you over the phone what the invoice date said?

A No.

Q Did you ask?

A No.

Q Why?

A I verified that it was in the June -- January time frame of '02. What I was looking for was a copy of the brochure. That's what I was -- I wanted to see if he could print out a hard copy of the brochure. And he said that would -- it was buried in his records, and it would take a lot of time because they did thousands of jobs.

Q So what exactly did he verify for you that you're relying on as recollection for your declaration?

A That they printed it in January 2002.

Q Do you have any evidence that what he printed is the copy that you have as Attachment A to deposition Exhibit 2?

A The time, the date timestamp, not date time. There's not a time associated with the -- but the printing date of Rev A, Rev A 1/02. January of '02.

Q Didn't you just testify that the individual at Buffalo Brothers couldn't tell you dates because it would take too much time and effort to do?

A He couldn't -- he couldn't extract the specific hard copy of a brochure.

Q So, did he tell you a date that it was printed?

A Just that he verified that it was a January '02 run.

Q How did he verify it?

A Through financial records. There's a difference in his system between a financial record and the actual -- the artwork. It was two different systems. One was an accounting system, and that was easy to get to. But getting the hard copy of the brochure would be --

Q And what specifically of the financial records date did he give you?

A January of '02.

Q And you never asked for a copy of that; is that correct?

A Correct.

Q And you testified that, in your records, you will be able to get the name of that individual; isn't that correct?

A Yes.

Q Was that individual able to tell you in that -- whatever record he looked at, what else was printed maybe on January 2002?

A No.

Q Was that individual able to tell you from his record what exactly was printed?

A He had a -- he had an invoice for the printing run that he made in January of '02.

Q Did he tell you exactly what the line item was in that invoice?

A He verified that it was the Merlin brochure printed in January of '02.

Q Okay. How was he able to verify that to you?

A I don't know.

Q So as you sit here today, do you have any personal knowledge that the date that is on Exhibit 2, Attachment A, is a date that Buffalo Brothers printed that Merlin brochure?

A No.

Q Can we turn to paragraph 6, still, of Exhibit 2? In paragraph 6, I'm going to start with the sentence after "Orlando, Florida." It says:

"The brochure was also available directly from Indigo's website as of January 2000 date."

Do you see that?

A Yes.

Q And you said:

"I was able to validate this by our internal records as well as through the use of the Wayback Machine."

Do you see that?

A Yes.

Q What company owns the Wayback Machine?
A I don't know.
Q Do you know how the Wayback Machine gathers data?
A No.
Q Did you make any inquiry on how that data is gathered?
A No.
Q And how many times did you go on to the Wayback Machine before you attested to the statement on paragraph 6?
A At least once.
Q When did you go on the Wayback Machine?
A I went on there with legal counsel in February of 2014.
Q And what internal records are you talking about?
A That's the Buffalo Brother records I was talking about. It was in reference to records, was the Buffalo Brothers... the investigation. I went to try and get a copy of that.
Q Why did you feel to use the word "internal"? Is Buffalo a part of FLIR? I'm sorry. Strike that.
Is Buffalo Brothers a part of Indigo or FLIR?
A No.

Q So why did you choose to use the word "internal" if it's not documents kept inside the company?

A I don't recall.

Q Would you like to change the word "internal" records to be more precise, as you sit here today?

A No.

Q So you are still comfortable using the word "internal" records?

A Yes.

Q So other than the two phone calls to Buffalo Brothers and the one instant using the Wayback Machine, is there any other way you confirmed that the attachments that's Attachment A to this declaration is a copy of a Merlin brochure that was available at least in January 2002?

MR. GABRIC: Object to form.

THE WITNESS: No.

BY MR. VINNAKOTA:

Q Did you have any of these copies in your personal file?

A No.

Q Were you asked to look for it?

A Yes.

Q And were you able to find any?

A No.

Q Go to paragraph 7. The title before paragraph 7 says "The Merlin User Guide."

Do you see that?

A Yes.

Q And this is referring to Attachment B; is that correct?

A Correct.

Q Now, the sentence says (as read):

"The Merlin Users Guide is a user guide that describes the Merlin Mid camera sold by Indigo in at least the 2000 to 2000 (sic) time frame."

Is that correct?

A 2004, yes.

Q 2004 time frame.

Is that correct?

A Correct.

Q Is Attachment B the only user guide used by Indigo in that 4-year time frame?

A No.

Q How do you know that?

A Because there was a user guide for the Phoenix camera as well.

Q Let me be more precise.

Is the Attachment B user guide, Merlin User Guide, the only Merlin User Guide used to describe the Merlin Mid camera sold by Indigo in at least the 2000, 2000 -- 2004 time frame?

A There would have been others. As the product matured and evolved, the user guide would have been revised to reflect technical changes in the camera.

Q Do you know how many evolutions of the user guide there were?

A No.

Q Let's turn to Attachment B, shall we? Can you tell me from just the front of this document where the -- in the evolution time frame this user guide was developed?

A No.

Q Do you have any knowledge of that?

A No.

Q Do you have any personal knowledge?

A No.

Q Turn back to paragraph 7. Second sentence says:

"The Merlin Users Guide document was distributed to customers with the Merlin Mid camera."

Do you see that?

A Yes.

Q Were you involved in the distribution of the Merlin user guides to customers?

A Yes.

Q In what capacity?

A As, uhm, as an adjunct to the sales cycle to send out to a customer.

Q Did you send this specific user guide to a customer?

A I almost certainly would have. That was the users guide that covered the camera. That would be a yes.

Q Paragraph 8 says:

"The Merlin User Guide was also available for download directly from Indigo's website."

Do you see that?

A Yes.

Q How did you verify that statement?

A I don't recall.

Q Did Indigo have a website in June of 2000?

A Yes. Yes.

Q Did you maintain that website?

A No.

Q Did you develop that website?

A No.
Q Did you write the HTML code for that website?
A No.
Q Did you upload documents on that website?
A No.
Q Did you change documents off that website?
A No.
Q Do you know who did?
A No.
Q Did you ever, personally, download the Merlin User Guide off that website in June 2000?
A I don't recall.
Q Did you ever at any time download the Merlin User Guide off any website?
A I didn't need to download it from the website. I had it available internally. No.
Q So you don't have personal knowledge that the user guide was actually available for download directly from Indigo's website, do you?
A No. It's my recollection that it was available from the website.
Q But you can't -- what's that recollection based on?
A It's a general tool. The website is a general tool that is used to communicate with the customers.

Q Did you ever direct customers to the website while you were at Indigo?

A Yes.

Q Do you talk about that on your declaration?

A No.

Q Do you talk about ever telling a customer to download the user guide off the website?

A No.

Q And you already testified you weren't even maintaining the website; is that correct?

A Correct.

Q And you already testified you don't even know who created the website; is that correct?

A You are correct. I don't know who. Somebody was behind the code, but it wasn't in my wheelhouse.

Q And you testified earlier that during the development phase of a Merlin Mid, there could be an evolution of the user guide; isn't that correct?

A Yes.

Q And you have no personal knowledge whether or not, if the user guide changed versions, that the website was updated, do you?

A Correct.

Q Let's turn to paragraph 9. Now, why did you add paragraph 9 to this declaration?

MR. GABRIC: I'll just caution you not to reveal the substance of any communications with counsel.

THE WITNESS: I don't understand the question.

BY MR. VINNAKOTA:

Q Why did you add paragraph 9 to this declaration?

A To identify whether Merlin Mid cameras were sold with custom cold filters.

Q Did you have to use the Merlin brochure, Merlin User Guide to articulate the assertions in paragraph 9?

MR. GABRIC: Objection to form.

THE WITNESS: No.

BY MR. VINNAKOTA:

Q Why is that?

A It wasn't necessary to refer to the brochure to tell somebody that a custom cold filter was available as an option. That's what we did.

Q Can you repeat what you just said?

A It's what we did. It was our job.

Q Describe that job then. If a customer came to you, asking for a, what you call, using your words, a custom cold filter, what did you do?

A We would -- we would explore the application and then be able to make recommendations on how to achieve what their end goal was.

Q What kind of applications did customers come to you asking for a custom cold filter?

A Species specific, species detection. From a scientific perspective, to look for specific emissions, fugitive emissions, gas plumes, rocket, rocket exhaust, other scientific kinds of applications in laboratory spectroscopy.

Q Who came to you asking for emissions applications?

A Numerous customers.

Q Do you list any of those customers in paragraph 9?

A No.

Q Can you tell me, from your personal knowledge, what some of those customers were?

A Uhm, yeah. The telecommunications industry. The gas industry.

Q Do you have -- I'm sorry. Go ahead.

A Jet propulsion laboratory, those kinds of customers.

Q Let's go back to telecommunications industry.

Do you have any specific company name?

A No. I don't remember, but in the beginning, the fiberoptic industry was virgining. And so, they were interested in typically outside the Merlin Mid or

just at the bottom of the Merlin Mid responsivity curve.

Q And I think you said the gas industry; is that correct?

A Yes.

Q Do you know any companies in the gas industry that are looking for emissions?

A The Leake Company, Jeff Leake.

Q Anyone else?

A Not that I can recall specifically.

Q And what do you recall about The Leake Company asking you about emissions?

A That -- if we could manufacture a camera for gas emissions.

Q Anyone else?

A I don't recall.

Q You also mentioned fugitive emissions.

Do you recall that?

A That's a term that is used for like a first responder if there was, say, for instance, a -- like a train wreck. First responder would want to come up. Before they commit their fire resources, they would like to know what it is that they are sending the firefighter into.

Q Do you know what companies were asking for that?

A No, I don't recall.

Q Would there be records at FLIR or Indigo that would refresh your memory?

A Sure. You could look at -- you could discern those customers by looking at our billed records for the cameras that were -- that were sold. You could go back and look at the configuration log to determine what the specific filters were.

Q Could those configuration logs tell you what applications they were used for?

A No, but it was -- it wouldn't specifically say what they were going to -- what the customer -- sometimes the customer wouldn't tell us what they were going to use it for.

Q How are you aware that Jeff Leake was looking for a gas -- I'm sorry -- for an emission, I believe you said, an emission application instrument?

A I've been working with Jeff since the early '90s.

Q Do you know who Jeff Leake was working with or for to get that instrument?

A Yeah. He had many customers. Yes.

Q Who were some of his customers?

A Well, the subject Furry brothers were one of them. He sold cameras to numerous entities.

Q So other than Jeff Leake, can you tell me any other instance when a customer came to you asking for a custom filter to look for hydrocarbon gas detection in an industrial setting?

MR. GABRIC: Objection to form.

THE WITNESS: Not specifically.

MR. VINNAKOTA: Let's take a break.

THE VIDEOGRAPHER: Time is 2:59 p.m. We are off the record.

(Off the record.)

THE VIDEOGRAPHER: Time is 3:08 p.m. We are back on the record.

BY MR. VINNAKOTA:

Q Sir, do you intend to execute any additional declarations in this matter?

A Not unless I'm asked to.

MR. VINNAKOTA: At this time, we are about to pass the witness, but I would just have -- ask for the same stipulation that we've done before; that should this witness put any supplemental declarations in these IPR proceedings, we reserve the right to depose. And since these topics were limited scope, there is a stayed litigation matter, that this witness will be subject to

the full rights that we have, we being Leak Surveys, on deposing the individual in the co-pending litigation.

At this time, we pass the witness if you agree to the stipulation.

MR. GABRIC: Yeah. I -- if he offers a supplemental declaration, we will make him available for deposition. And like the prior deposition, this deposition is for the IPR. I don't think it has any impact on what you may elect to do in this court case.

So, I'm going to take about a 10-minute break and see if I have any questions, and then go forward.

THE VIDEOGRAPHER: Time is 3:09 p.m. We are off the record.

(Off the record.)

THE VIDEOGRAPHER: The time is 3:38 p.m. We are back on the record.

EXAMINATION

BY MR. GABRIC:

Q Welcome back, Mr. Malmberg. I just have a few questions. All right, sir? Okay.

A Yes.

Q All right. Can you please take a look at Exhibit 2, Malmberg Exhibit 2? You have that in front of you?

A I do.

Q All right. And Attachment A, could you identify what that is?

A Attachment A is the Merlin family brochure.

Q Okay. And that brochure is referenced your declaration?

A Correct.

Q All right. And what's Attachment B, sir?

A Attachment B is the Merlin Mid Users Guide.

Q Okay. And that document is referred in your declaration?

A Correct.

Q Okay. And did you review these documents before signing your declaration?

A Yes, I did.

Q All right. Are you familiar with those documents before you signed your declaration?

A I was.

Q And is that also true with respect to the subsequent declarations you signed in this matter, Malmberg 3 through 5?

MR. VINNAKOTA: Objection. Form.

BY MR. GABRIC:

Q Were you familiar with Attachments A and B that's set forth here in Malmberg 2?

A Yes.

MR. VINNAKOTA: Objection. Form.

BY MR. GABRIC:

Q Okay. And did you review each of your declarations for accuracy before signing them?

A To the best my recollection, yes.

Q Okay. Now, could you please turn to Malmberg 3, please? And I'd like to focus on paragraphs 5 and 6. Give you a moment to review that.

Let me know when you are done reviewing it, okay, sir?

A Yes.

Q Done reviewing 5 and 6?

A I am.

Q All right. Those paragraphs refer to a trade show in April 1 through 4, 2002.

Do you see that?

A I do.

Q All right. And were you at that trade show referred to in paragraphs 5 and 6?

A I was.

Q And how, sir, do you know that you attended that trade show in April of 2002?

MR. VINNAKOTA: Objection. Form.

THE WITNESS: I attended the -- the trade show, SPIE conference, for all of the years, from 2001, '2, '3, and '4.

BY MR. GABRIC:

Q And how do you know that?

A Because I -- I ended up missing Easter dinner with my family for 4 years in a row, and I took a lot of -- took a lot of criticism on the home front for always traveling on Easter Sunday to go to a trade show.

Q So would you travel down to the trade show before it commenced to help set up things?

A Yeah. I was involved with the setup of the booth and the... carting the boxes in, setting the booth up, preparing the booth.

Q Okay. And is there any doubt in your mind whatsoever that you were at that trade show, the ThermoSense trade show down in Orlando on April 1 through 4, 2002?

MR. VINNAKOTA: Objection. Form.

THE WITNESS: None whatsoever.

BY MR. GABRIC:

Q All right. Now, Attachment A to Malmberg 3,

it's the Merlin brochure, right?

A Yes, it is.

Q All right. And in this declaration, you testified that it was this brochure, Attachment A, that was handed out at the April 1 through 4, 2002 trade show referred to in your declaration, correct?

A Correct.

MR. VINNAKOTA: Objection. Form. Let me finish my objection.

MR. GABRIC: Yeah, sure.

MR. VINNAKOTA: Objection. Outside the scope of cross-examination.

MR. GABRIC: You done? Okay.

BY MR. GABRIC:

Q Now, sir, how do you know it was this specific brochure, Attachment Exhibit A, that that's the brochure that you handed out at that trade show in April 1 through 4, 2002?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross-examination.

THE WITNESS: Because the product line had significantly changed and necessitated us to change the brochure to reflect current status of the product line.

BY MR. GABRIC:

Q And so, was there a prior version of this

brochure?

A There was.

Q And were there differences between that prior version and the version that's attached as Exhibit A to your declaration that reflect the change in product line?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: It does. It does not include the Merlin Quip camera. There were only three variants of the Merlin camera.

BY MR. GABRIC:

Q What are you referring to, sir?

A There was -- on the earlier version of the brochure, there was a single page cut sheet, and it had four, separate, Merlin cameras associated with it. There was the NIR, the Mid, the Quip, and also then the Microbolometer. So, there were two long wave, one NIR infrared and one Mid wave.

And additionally, there was a big splash with our third party, Talon, and Thermoteknix digital acquisition -- data acquisition systems.

Q That's the prior brochure?

A That -- we didn't have it on the prior brochure because we hadn't developed those two products. So this

was a -- we changed the focus of the brochure from a one-page cut sheet to a multi, multipage foldout that included a -- dropped the Quip camera, and included the Talon acquisition and the Thermoteknix, the ThermaGRAM system.

Q Mr. Malmberg, I want to make sure that the record is clear, so let's take this in baby steps.

A Okay.

Q The -- what is in the Attachment A to your declaration, what is in that brochure that was not in the prior brochure, to the best of your knowledge?

MR. VINNAKOTA: Objection. Form. Objection. Beyond the scope of cross.

THE WITNESS: The -- the absence of the Merlin Quip camera in this brochure.

BY MR. GABRIC:

Q What brochure, sir?

A In the 2002 brochure.

And the addition of the Talon acquisition and the ThermaGRAM data acquisition subsystems were not -- were not in the first version of the Merlin family. It was a one-page cut sheet that did not include this much data.

Q And when were these changes made to the product line that are reflected in the --

A We were --

Q Hold on. Let me get my question out.

When were these changes made in the product line that are reflected in the brochure that's attached as Exhibit A to the declaration?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: During 2001.

BY MR. GABRIC:

Q And do you recall being involved in the preparation of the brochure that's attached as Exhibit A?

A Yes, I do.

Q Okay. And was there any particular event that you folks were working towards to have this brochure ready for?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: Yes. The SPIE conference was the single main event in our industry.

BY MR. GABRIC:

Q And that's the SP -- the SPIE conference that's referred to or the ThermoSense conference that's referred to in the declaration?

A Yes.

Q All right. So, you folks were targeted to have this brochure completed for the April 1 through 4, 2002 ThermoSense conference we have heard in your declaration?

MR. VINNAKOTA: Objection, form. Objection, outside cross.

THE WITNESS: Yes.

BY MR. GABRIC:

Q And why was that?

MR. VINNAKOTA: Same objection.

THE WITNESS: It was a big deal. The absence of the Quip to accurately reflect that change in the product line, we wanted to get that out of the brochure. But the -- in particular, the Thermoteknix and the acquisition with the third party company, we teamed with them because they had a best-of-breed acquisition system. So we needed to include that in the brochure.

BY MR. GABRIC:

Q And so, was this brochure completed then by the April 2002 ThermoSense conference?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: Yes. We went to print and printed this brochure in January in preparation for the April show.

BY MR. GABRIC:

Q And sir, did you personally hand out this brochure, Attachment A, at the ThermoSense conference in April of 2002?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: Yes, I did.

BY MR. GABRIC:

Q Approximately how many copies of this brochure did you hand out?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: Approximately 100 to 200 brochures over the 4 days.

BY MR. GABRIC:

Q And was this conference open to the public?

MR. VINNAKOTA: Objection, form. Objection, outside the scope of cross.

THE WITNESS: Yes, it was.

BY MR. GABRIC:

Q And so, you do have personal knowledge, sir, that this brochure existed certainly by the time of April 2002 when you, yourself, were handing this brochure out at that conference; is that correct?

MR. VINNAKOTA: Objection, form. Objection,

outside the scope of cross.

THE WITNESS: Absolutely.

MR. GABRIC: Take a break, few minutes.

THE VIDEOGRAPHER: Time is 3:47 p.m. We are off the record.

(Off the record.)

THE VIDEOGRAPHER: Time is 3:52 p.m. We are back on the record.

MR. GABRIC: Oh, I'm sorry. Everyone is waiting on me.

MR. VINNAKOTA: Is that some strategy that you have or something? Jesus. That's awesome.

MR. GABRIC: Don't get old. This is what happens. I pass the witness. I apologize. Traveling a lot lately.

MR. VINNAKOTA: You work with him.

CONTINUED EXAMINATION

BY MR. VINNAKOTA:

Q Sir, all the testimony that you just gave to your counsel, can you point to me any place of any of

your declarations where that is?

MR. GABRIC: Objection. Compound.

THE WITNESS: No.

BY MR. VINNAKOTA:

Q In the break, prior to the redirect examination of your counsel, did you speak to your counsel about the answers you were going to provide?

A Yes.

Q What did you guys talk about?

MR. GABRIC: Objection. Instruct you not to answer. Privilege.

(Witness instructed not to answer.)

MR. VINNAKOTA: Is it your position that cross-examination ends on the first cross-examination and not the entirety of the deposition?

MR. GABRIC: Yeah.

MR. VINNAKOTA: I think we are going to call the board then. Let's go off the record for a second.

THE VIDEOGRAPHER: Sure. Time is 3:54 p.m. We are off the record.

(Off the record.)

THE VIDEOGRAPHER: Time is 4:16 p.m. We are back on the record.

BY MR. VINNAKOTA:

Q Sir, prior to the break, before redirect examination, did your counsel suggest how you should answer any of the questions that he posed to you?

MR. GABRIC: I'll object to the question. It seeks privileged information.

MR. VINNAKOTA: We are going to call the board. Are you instructing him not to answer?

MR. GABRIC: Yeah. I'm instructing him. You are seeking privileged communications.

(Witness instructed not to answer.)

MR. VINNAKOTA: Even though it's a yes or no answer?

MR. GABRIC: Yeah. It goes to the substance of the communications.

MR. VINNAKOTA: We are going to call.

MR. GABRIC: It's also -- the question is vague.

MR. VINNAKOTA: We are going to call the board on that one question.

MR. GABRIC: Okay.

MR. VINNAKOTA: We will still stay on the record while we get the number.

MR. PUCKETT: Well, we might want to go off the record while we get the board.

MR. GABRIC: Yeah.

THE COURT: Time is 4:16 p.m. off the record.

(Off the record.)

THE VIDEOGRAPHER: Time is 4:20 p.m. We are back on the record.

MR. VINNAKOTA: So, we attempted two attempts, counsel, you can verify, to contact the board for resolution on the one question that patent owner would like guidance on. At this time -- and the purpose for the call was to try to get a ruling from the board whether or not the objection, privilege objection should be sustained or overruled.

Counsel, I mean, I have no other questions other than that, so --

MR. GABRIC: Okay.

MR. VINNAKOTA: -- my suggestion, if you agree, is we take it up with the board at the earliest convenience possible. If that objection is overruled, unfortunately, we may have to seek or recall the witness

at that point. So we are going to still keep this deposition open up until then. So, however you want to play it.

MR. GABRIC: I'm happy to play it that way. Looks like we got to play it that way given we can't get the judge right now.

MR. VINNAKOTA: So, at this time, we will suspend this deposition. We are not ending it at this moment until we get final resolution of that question.

THE VIDEOGRAPHER: Ready to go off the record?

MR. VINNAKOTA: Off the record.

THE VIDEOGRAPHER: This concludes today's deposition of Roy Malmberg --

MR. GABRIC: Let me reserve signature. I'm not sure I have to expressly say that in this proceeding, but I'm going to reserve signature, counsel.

MR. VINNAKOTA: Fair enough.

THE VIDEOGRAPHER: All right. This concludes the deposition of Roy Malmberg. The number of media used was one. The time is 4:21 p.m. We are off the record.

(Off the record.)

(Deposition proceedings were concluded at 4:21 p.m.)

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I, ROY MALMBERG, hereby certify under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this _____ day of _____, 20___, at _____, California.

_____

ROY MALMBERG

STATE OF CALIFORNIA)
) ss.
COUNTY OF LOS ANGELES)

I, ERIKA A. SJOQUIST, C.S.R., R.P.R., C.R.R., C.S.R. NO. 12350, a Certified Shorthand Reporter in and for the County of Los Angeles, the State of California, do hereby certify:

That, prior to being examined, the witness named in the foregoing deposition was by me duly sworn to testify the truth, the whole truth, and nothing but the truth;

That said deposition was taken down by me in shorthand at the time and place therein named, and thereafter reduced to typewriting by computer-aided transcription under my direction.

I further certify that I am not interested in the event of the action.

Witness my hand this _____ day of _____, 20___.

_____
Certified Shorthand Reporter
in and for the County of
Los Angeles, State of California

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FLIR Systems, Inc.
Petitioner

v.

Leak Surveys, Inc.
Patent Owner

Trial No.: IPR2014-00411
U.S. Patent No. 8,426,813 B2
U.S. Patent No. 8,193,496 B2

PATENT OWNERS' AMENDED NOTICE OF DEPOSITION OF ROY D. MALMBERG UNDER 37 C.F.R. § 42.53

Please take Notice that pursuant to 37 C.F.R. § 42.53, and as previously informed to the Board during the December 4, 2014 conference call, Patent Owners, by and through its attorneys, will conduct cross-examination by deposition of Petitioner's declarant, **Roy D. Malmberg**. In accordance with 37 C.F.R § 42.53(d)(1), the Parties have conferred and agreed that the deposition will take place **commencing at 9:00 AM PST on January 16th, 2015** and continuing from day-to-day, if necessary, at the offices of McDaniel's Court Reporting, 21 E. Carrillo St., Suite 190, Santa Barbara, CA 93101.

The cross examination will be taken before a Notary Public or other office authorized by law to administer oaths. It will be recorded by both stenographic and video means.

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Attorneys for Leak Surveys, Inc.

CERTIFICATE OF SERVICE

The undersigned hereby certifies that, pursuant to 37 CFR 42.6(e)(1), the parties have agreed to electronic service for all filings in this case. Pursuant to that agreement, Patent Owner hereby certifies that the foregoing Notice was served via email upon the following parties. A courtesy copy of the aforementioned filing will follow by U.S. Express Mail upon the following:

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Attorneys for Leak Surveys, Inc.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: David W. Furry	)	
U.S. Patent No. 8,426,813	)	
Issued April 23, 2013	)	
Based on U.S. App. No: 13/462,609	)	
Filed: May 2, 2012	)	
For CHEMICAL LEAK INSPECTION SYSTEM	)	*Inter Partes* Review Case No.: TBD

DECLARATION OF ROY D. MALMBERG

1. My name is Roy D. Malmberg, and I worked for Indigo Systems Corporation ("Indigo") from June, 2000 until it was acquired by FLIR Systems Inc. ("FLIR") in 2004. I have been employed at FLIR since the acquisition, and currently hold the title of Director, MTU (Mobile Training Unit) Program. In this role, my duties and responsibilities include management of FLIR Systems' Mobile Training Unit Program as well as coordinating the activities of FLIR's Inside Sales Team.

2. At Indigo, I held the titles of Sales Engineer and then Sales Manager. In that role, my duties and responsibilities included supporting the outside sales channel, testing and evaluation of thermal camera systems, attending trade shows in support of the sales cycle and supervising Indigo's pool of demo assets, and generally promoting sales of the products, including the Merlin and Phoenix thermal imaging cameras.

3. I have been asked to identify, based on my experience at Indigo, when the two publications discussed in this Declaration were published. The Merlin Brochure and Merlin User's Guide were both in use when I was working at Indigo.

4. I have reviewed copies of each publication. I understand that each publication is being relied upon by FLIR in an *inter partes* review proceeding before the U.S. Patent and Trademark Office. The two publications are listed below:

- Indigo Systems Corporation, "Merlin, The Ultimate Combination of Flexibility and Value in High-Performance Infrared Cameras" ("the Merlin Brochure") (attached to this Declaration as Attachment A)
- Indigo Systems Corporation, "Merlin-MID, InSb MWIR Camera, User's Guide," Version 1.10, 414-0001-10 ("the Merlin User's Guide") (Attachment B)

5. I will address each publication in turn.

The Merlin Brochure

6. The Merlin Brochure is marketing material describing, among other things, several Merlin cameras offered by Indigo. The Merlin Brochure was being freely distributed to the public as of January, 2002. It was standard procedure to include hardcopy of the Merlin Family brochure as part of a data package when sending our pricing quotations or in response to customer inquiries. The brochures were also passed out to the general public at the SPIE trade shows held annually in Orlando, Florida. The brochure was also available directly from Indigo's website as of the January 2002 date. I was able to validate this by our internal records, as well as through the use of the waybackmachine.org to confirm the same brochure was published on the Indigo web site as of January 2002.

The Merlin User's Guide

7. The Merlin User's Guide is a user guide that describes the Merlin-MID camera sold by Indigo in at least the 2000 to 2004 timeframe. The Merlin User's Guide document was distributed to customers with the Merlin-MID camera. The Merlin-MID camera was being offered for sale when I joined the company in June of 2000.

8. The Merlin User's Guide was also available for download directly from Indigo's website when I joined the company in June of 2000.

The Merlin-MID Camera

9. I have also been asked to identify whether Merlin-MID cameras were sold with custom cold filters. As early as June 2000, it was Indigo's common practice to allow a customer to customize their Merlin-MID camera build with a cold filter having a specific spectral bandpass. Cold filters were occasionally supplied by the customer, while some cold filters were selected based on our experience. Other builds were requested with no cold filter installed, which would result in the dewar window acting as the only spectral filter. This customization process was driven by the customer's bandpass of interest and what they were trying to detect.

I declare under penalty of perjury of the laws of the United States that all statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true.

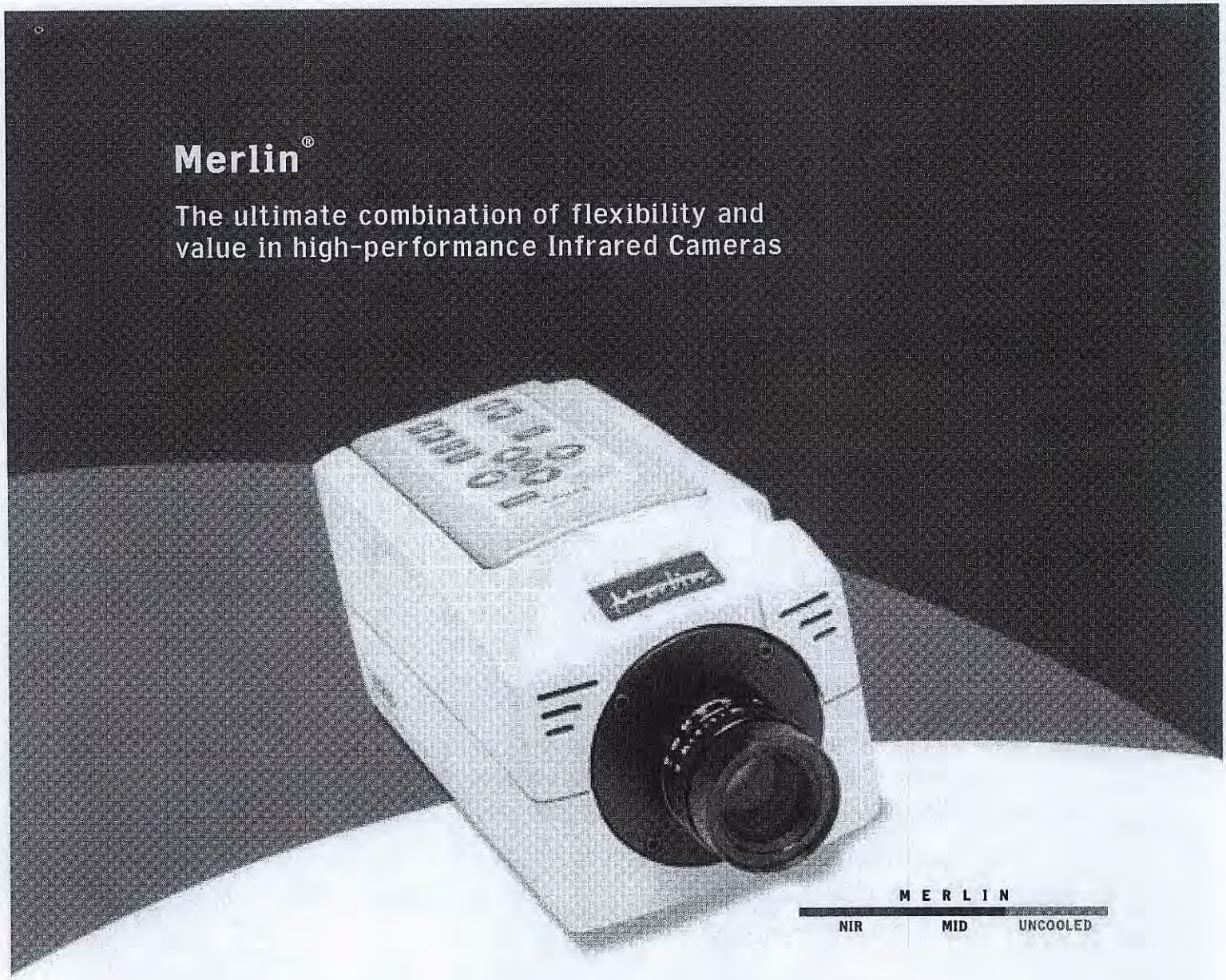
Executed February 6, 2014 at Goleta, California.

Roy D. Malmberg

Attachment A

Merlin®

The ultimate combination of flexibility and value in high-performance Infrared Cameras



- > Merlin® Camera Family
- > Talon® Data Acquisition
- > ThermaGRAM® Data Acquisition
- > Infrared Optics

indigo™

brighter.

Merlin® Advantages

- 320 x 256 FPA for high resolution images
- Complete range of FPA options for NIR, MWIR, or LWIR
- Variable integration time avoids image saturation problems
- 60 Hz frame rate for real-time applications
- Low-noise electronics design for high-sensitivity applications
- Common electrical and software interface between cameras
- Choice of radiometric or imaging camera systems

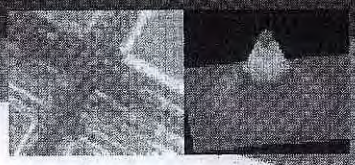
Indigo Systems provides all of this and more. From near infrared spectroscopy, to process control using long wavelength IR, the amazing diversity of infrared imaging applications means that a single IR camera can't provide the optimum performance needed for every application. That's why Indigo designed the **Merlin**® family of cameras with more options and flexibility than any other commercial high-performance infrared camera. In fact, Merlin provides an unparalleled combination of factory-optimized and field-customizable features, including wavelength band, imaging optics, variable integration time, and data processing software. This means that Merlin can be perfectly matched to your application.

Merlin is offered with a complete choice of low-noise focal plane arrays (FPAs) covering all IR spectral bands. This includes InGaAs, InSb, and Uncooled Microbolometer arrays. These FPAs are supported by a full spectrum of cooling options: TE stabilization (InGaAs & Microbolometers); and liquid nitrogen or Stirling cryogenic cooling (InSb). A broad range of interchangeable IR lenses is available for each wavelength range, including microscope and telescope optics.

All Merlin cameras operate at a 60 Hz (50 Hz PAL) frame rate with software adjustable integration time, or electronic iris, to accommodate a wide range of flux levels. Both radiometric and non-radiometric models are available, with a choice of **ThermaGRAM**® radiometric software or **Talon**® digital data processing software. Digital data is generated and processed at full 12-bit resolution.

This combination of flexibility and high-performance is a direct result of Indigo's commitment to total vertical integration. We design, manufacture and assemble all critical components in-house, from the readout integrated circuits (ROICs), to the focal plane arrays, and final Merlin camera assembly.

Merlin NIR
InGaAs



> Image through silicon and other semiconductor materials

> Precision analysis of NIR lasers

APPLICATIONS

Telecom Laser Beam Profiling
Silicon Inspection
Forensic Science
Spectroscopy
Food Inspection

BENEFITS / FEATURES

> **Precision analysis of NIR lasers (e.g., S-, C-, or L-band telecom lasers).** Greater than 99% linearity across the dynamic range makes Merlin NIR a must-have tool.

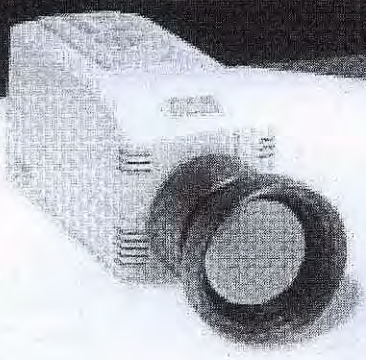
> **A single system for measurement of signal levels across a very wide intensity range without the use of neutral-density filters.** The NIR camera's adjustable integration time (1 µs - 16.5 ms) expands the dynamic range by four orders of magnitude (a factor of 10,000). Two gain modes provide an additional order of magnitude of dynamic range.

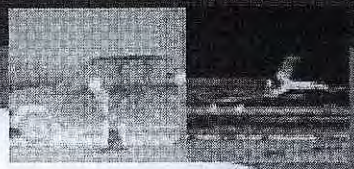
> **High resistance to laser damage.** Solid-state InGaAs detectors withstand energy intensities greater than 10 W/cm² with no image retention.

> **The ability to image through semiconductor materials, for applications such as silicon wafer inspection from the back side.** Unlike CCD cameras, Merlin NIR permits imaging well beyond the cutoff wavelength of 1100 nm in silicon.

> **Radiometric measurement through glass windows.** Merlin NIR can be used for radiometric imaging through materials that are opaque to MWIR and LWIR light. The InGaAs waveband offers significant enhancement in sensitivity over silicon CCD cameras.

Merlin MID
InSb





> Long-range detection and surveillance

> Detection of chemical signatures in aircraft exhaust

APPLICATIONS

Long Range Surveillance
Military FLIR
R&D Labs
Non-Destructive Testing

BENEFITS / FEATURES

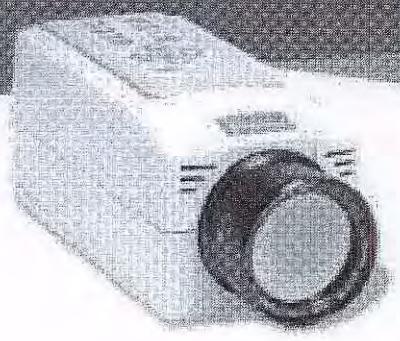
> **Detection of minute temperature changes within a scene.** Temperature differences as small as 0.018 °C are easily distinguished by the indium antimonide sensor in the Merlin Mid. For the ultimate in sensitivity and temperature measurement, ThermaGRAM and Talon both enable post-processing analysis tools including signal averaging, background subtraction, and emissivity correction.

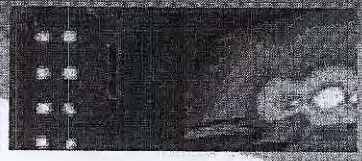
> **Higher signal-to-noise ratio.** In reduced frame rate modes of 30 or 15 Hz, integration times as long as 33 and 66 ms, respectively, can be achieved.

> **Long-range detection and surveillance, particularly in marine environments.** The Merlin Mid with our dual field-of-view (50/250 mm) or triple field-of-view (60/180/500 mm) telescopes provides a powerful, integrated imaging solution at long standoff distances.

> **Detection of chemical signatures in aircraft, rocket and missile exhaust.** CO_2 spectral lines fall within the 3-5 µm waveband. The filter wheel option available for the Merlin Lab camera permits wavelength selectivity for spectroscopy and signature analysis.

Merlin Uncooled Microbolometer





> High thermal contrast process control and condition monitoring

APPLICATIONS

Smoke/Haze Penetration
Security
Process Control
Mine Detection
Gas Detection

BENEFITS / FEATURES

> **Economical radiometric solution for high thermal contrast process control and condition monitoring.**
Uncooled sensor operating in the LWIR waveband permits measurement of temperatures in the 0-500 °C range (500-1000 °C with optional ND filter).

> **High-reliability, low-cost, fast time to imaging.**
Long-life thermoelectric cooler enables time to image of less than 1 minute.

> **Immune to sunlight reflections.**
Eliminates sun glints and "clutter" in landmine detections and other outdoor applications.

> **Ability to image through smoke.**
The LWIR band is uniquely suited to observation through smoke particles, which are smaller than the wavelength of LWIR light.

Talon® Data Acquisition

> **Indigo offers Talon Ultra, a digital acquisition and analysis system** consisting of a digital grab board, 10-foot interface cable, and all software required for image acquisition and analysis. The 12-bit digital data is available from the Merlin camera for transfer to the frame grabber board. These components are configured and delivered in a Pentium-class computer.

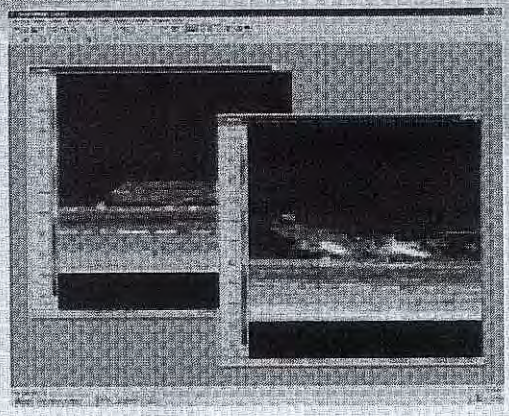
> **The Talon Ultra software is based on a licensed copy of Image Pro® software with custom extensions.** The software provides a full range of utilities for processing, measurement, and analysis. Talon Ultra is ideally suited for any research professional using Indigo's Merlin IR cameras to capture, study, manipulate, and store images and data.

> **Talon Lite Option,** a simplified version, available for basic data acquisition only.

ThermaGRAM®
Data Acquisition

DEVELOPED BY
Thermoteknix Systems Ltd

ThermaGRAM is a real-time infrared image processing system. When combined with Indigo radiometric and non-radiometric cameras, ThermaGRAM provides high-precision thermal image analysis with a wide array of tools and utilities. ThermaGRAM provides all temperature measurements in user selectable units, or in luminance for non-radiometric Merlin cameras.



Real-Time Radiometric Data Acquisition & Analysis

Analysis tools include:

- Spot temperature tools to display the temperature at a point in the image.
- Isotherm tools to color areas of the image lying within a defined temperature band.
- Line tools to be used as graphic objects or rulers, or to display the maximum, minimum and mean temperatures along a line, or with the profile tool to display the temperature profile along the line in a separate window.
- On-screen profile tools, which superimpose the display of a temperature profile over the image itself.
- Rectangle, ellipse and polygon tools to be used as graphic objects, or to display the maximum, minimum and mean temperatures in a region, and, with the histogram tool, to display a bar or pie chart showing the temperature distribution within the region.
- Differencer tools to display differences between the temperatures measured by other tools.
- Labels to identify points within the image.
- PosiTrak® tool is used for distance measurements by imposing a coordinate system via alignment marks.

ThermaGRAM Pro Option

ThermaGRAM Pro extends the standard ThermaGRAM with additional modules.

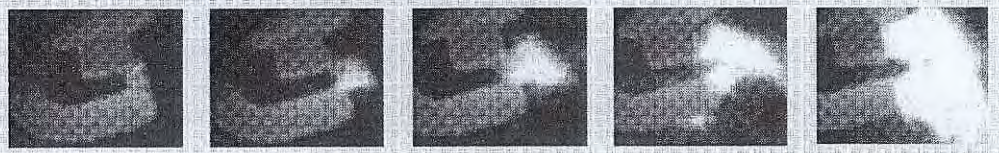
- ThermaGRAM Plot module allows data from a live image to be captured and plotted as Time versus Temperature graphs. Once the data is plotted, you can extrapolate to determine temperatures at future (or past) times, using a choice of models.
- The PosiTrak Pack module extends the PosiTrak tool, allowing you to straighten aligned images so that they appear the same as the original. You can also build a mosaic of overlapping images to create a single image; subtract one image from an image series; and create images showing the average, maximum, and minimum temperature of a group of images. PosiTrak uses a patented method of multi-image alignment and reorientation using quick and simple on-screen markers positioned on common features in the images.

Dynamite IR Option

The Dynamite IR program is a software accessory for ThermaGRAM Pro that enables real-time thermal image sequences to be captured. Dynamite IR controls the capture process and allows you to replay, edit, and save individual images or sequences; or to create .AVI files. Acquisitions may be triggered at any point from the beginning to end of an event, as image data is continuously streamed to the host computer's hard drive. Sequences can be initiated by digital signal input or keyboard, and user-defined time delays if desired. The length of sequences is limited only by available hard disk space. Dynamite IR uses proprietary technology to save onto standard PC hard disks, without the need to install disk arrays or SCSI interfaces.

Flame Kernel Growth in an Internal Combustion Engine

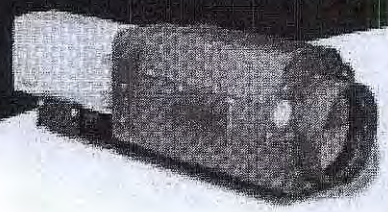
> **Dynamite IR option allows users to record and analyze sequences of images.**



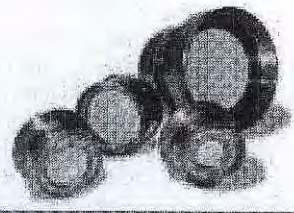
Courtesy of: Ford Motor Company

TheraGRAM is a registered trademark of Thermoteknix Systems, Ltd.

Optics/Camera Specs



Standard Infrared Optics
Indigo offers a variety of lenses and accessories for Merlin cameras. These optics have been selected to match the wavelength response and back working distance of the FPAs in our cameras. Lens Extender Rings available for MWIR and LWIR lenses.



Optics

NIR	MWIR	LWIR Uncooled
Microscope: 0.7x-22.5x (not shown)	Microscope: 1x, 2.5x, and/or 4x (not shown)	
	13 mm (41 x 31 degrees FoV)	13 mm (64 x 50 degrees FoV)
25 mm (22 x 16 degrees FoV)	25 mm (22 x 16 degrees FoV)	25 mm (36 x 27 degrees FoV)
50 mm (11 x 8 degrees FoV)	50 mm (11 x 8 degrees FoV)	50 mm (18 x 14 degrees FoV)
	100 mm (5.5 x 4.1 degrees FoV)	100 mm (9 x 7 degrees FoV)
12.5 mm - 75 mm Zoom	50/250 mm Dual Field of View 50 mm (11x 8 degrees FoV) 250 mm (2.2 x 1.8 degrees FoV) (not shown)	200 mm (4.7 x 3.5 degrees FoV) (not shown)
	60/180/500 Triple Field of View: 60 mm (9.1 x 7.3 degrees FoV) 180 mm (3.1 x 2.4 degrees FoV) 500 mm (1.1 x 0.9 degrees FoV)	

Camera Specifications

	Merlin NIR	Merlin MID	Merlin Uncooled
Detector Type	InGaAs	InSb	Microbolometer
Spectral Range	0.9 - 1.7 µm	1 - 5.4 µm (3 - 5 µm set by cold filter)	7.5 - 13.5 µm
Detector Size	30 x 30 µm	30 x 30 µm	51 x 51 µm
Array Format	320 x 256	320 x 256	320 x 240
Integration Time	1 µs - 16.5 ms	5 µs - 16.5 ms	N/A
Camera f/#	(set by lens iris)	2.5 or 4.1	1.3
Cooling Type	TE stabilization	Integral Stirling or LN_2	TE stabilization
NEdT [NEI]	[≤1E10 ph/cm² - sec, low gain] [≤5E9 ph/cm² - sec, high gain]	< 25 mK (< 18 mK typical)	< 100 mK
Analog Video	NTSC @ 30 Hz (PAL @ 25 Hz optional); S-Video		
Digital Video	60, 30*, 15* Hz (50 Hz PAL), 12-bit corrected/uncorrected (*Reduced frame rate option disables analog video. This option not available for Merlin Uncooled.)		
Remote Control	Button Pannel & RS-232	Button Pannel & RS-232	Button Pannel & RS-232
Size	4.0 "H x 4.5 "W x 8.0 "L	5.5 "H x 5.0 "W x 9.8 "L	4.0 "H x 4.5 "W x 8.0 "L
Weight	3.5 lbs	9 lbs	3.5 lbs
Standard Temp Measurement	250 - 1,000 °C	0 - 350 °C	0 - 500 °C
Extended Temp Measurement	1,000 - 2,000 °C	300 - 2,000 °C	500 - 1,000 °C
Temp Accuracy	2° or 2%	2° or 2%	2° or 2%

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indigo™

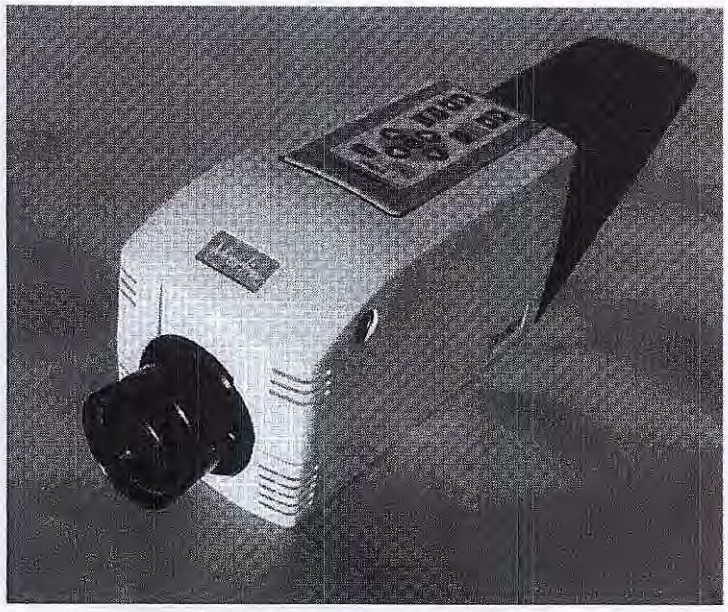
brighter.

Attachment B

Indigo SYSTEMS

Merlin™ Mid

InSb MWIR Camera



User's Guide
Version 1.1
414-0001-10

TABLE OF CONTENTS

1 Introduction

- Merlin Mid is a mid-wavelength infrared (MWIR) high-performance camera offered by Indigo Systems Corp. The camera consists of a Stirling-cooled Indium Antimonide (InSb) Focal Plane Array (FPA) built on an Indigo Systems ISC9705 Readout Integrated Circuit (ROIC) using indium bump technology. The FPA is a 320 x 256 matrix or 'staring' array of detectors that are sensitive in the 1.0 μm to 5.4 μm range. The standard camera configuration incorporates a cold filter that restricts the camera's spectral response to the 3.0-5.0 micron band. The FPA is enclosed in an all-metal evacuated dewar assembly cooled by a closed-cycle Stirling cryocooler, and is thermally stabilized at a temperature of 77 K.

- Merlin's signal processing electronics control the FPA, create timing and bias signals, perform analog-to-digital conversion, non-uniformity correction, replace bad pixels, automatically control the brightness and contrast of the display video when commanded (including histogram equalization for image display enhancement), output digital and analog video data and perform interface functions with external camera components.

- By design, the Merlin is operable by a remote button panel, or through the RS-232 serial port using either terminal emulator software or the Graphical User Interface (GUI). Advanced commands can only be executed through the RS-232 serial port via remote control.

- The camera chassis supports quick connect/disconnect optics. Several lens options with different focal lengths are available.

- A real-time, 60 Hz, 12 bit digital data stream is one of the camera's standard output formats.

- The Merlin is capable of being synchronized to an external RS-170 composite synchronization signal. This feature is especially useful in stereoscopic applications, where two cameras are used simultaneously.

- The camera operates on a single power input of 24 VDC, which is provided by an external power supply that plugs into a wall socket.

1.1 Camera Architecture

The Merlin Mid camera operates the InSb FPA in a single output, full frame, 6 Mpixel/sec mode. The full 320 x 256 FPA operates at a frame rate of 60 Hz in an NTSC camera configuration and at 50 Hz when operating in PAL configuration. The analog video frame rates are 30 Hz and 25 Hz for NTSC and PAL cameras, respectively. Integration time and video offset are user-adjustable through the remote button panel or RS-232 user interface. The camera supports both one- and two-point non-uniformity corrections. There are 4 sets of non-uniformity correction (NUC) tables stored in the camera, labeled NUC 0-3. The dewar is designed to use a closed-cycle Stirling cryocooler to stabilize the temperature of the FPA. The standard dewar f/number for the Merlin Mid camera is f/2.5, and the aperture is 0.414 inches in diameter.

The camera consists of:

- Detector/Dewar/Cooler Assembly
- FPA support PCB
- Camera Controller PCB
- Power Supply PCB
- Back Panel PCB
- Externally mounted Remote Button Panel
- Cal Flag Assembly

Note: The Merlin Mid camera does not come with a lens. This must be ordered separately.

Camera accessories include:

- AC/DC Power Supply
- User's Guide
- Graphical User Interface (GUI) software
- Shipping Container
- BNC Video cable
- S Video Cable
- Calibration Plates

Camera options include:

- f/2.3 MWIR Lens(es): 13mm, 25mm, 50mm, 100mm
- External Synchronization Generator

The back panel of the camera supports the interfaces for the remote button panel, the power on/off switch, the power input connector, video output connectors (NTSC or PAL and S-Video), the RS-232 connector, and the digital data interface connector (see Figure 4 in Section 4.2). Power is supplied to the camera through the 24 Volt DC supply. The camera can be controlled through the remote button panel or through the RS-232 output by connecting it to a computer and using the Graphical User Interface software or a terminal mode program such as HyperTerminal, described in Section 3.4.

1.1.1 Stirling-Cycle Microcooler

The focal plane array is cooled to a temperature of approximately 77 degrees Kelvin using a Stirling-cycle rotary cryocooler that is thermally coupled to the FPA via a cold finger. The Stirling cooler is a sealed refrigeration unit that uses helium as the working gas. It does not require the user to refill the camera with cryogens such as liquid nitrogen, and it is designed for long life and reliability. Helium is used because it will stay in the gaseous phase at 77 K even at high pressures. The cooler uses a compression step, followed by an expansion to remove heat from the cold finger. The compression and expansion process is repeated at a rapid rate, resulting in a low humming noise. The electronics in your Merlin camera controls the microcooler unit and achieves excellent temperature stability. The typical time to cool down the FPA to 77 K is 7-8 minutes, but the cooling may take longer if the camera temperature is elevated. For instance, if the camera is enclosed in a gimbaled housing on a land vehicle

operating in hot weather, the camera case temperature may be 45 C, requiring additional cooling time.

Note: If you are intending to perform a two-point correction, best results will be achieved if the temperature is allowed to stabilize for 30 minutes prior to performing the correction. This allows time for any time-dependent temperature fluctuations to settle out, and will result in a better correction.

1.2 Physical & Mechanical Interface

The camera body dimensions are 5.29 inches high, 5.0 inches wide, 9.9 inches long (excluding the lens). The chassis is fabricated from aluminum, and contains the sensor assembly and signal processing electronics. The camera weight is less than 8 Lbs (3.5 kg). The camera chassis base incorporates two tapped holes in line with the optical axis. The tapped holes are fitted with a helicoil insert to provide a 1/4" x 20 standard threaded insert. The holes are located 3.5 and 5.5 inches back from the camera's lens interface. Holes for locking pins are also available. See Appendix C for mechanical drawings of the Merlin camera.

1.2.1 Thermal Interface

Merlin is designed for convective cooling by means of internal fans. The chassis design is based on convective cooling with conductive cooling via placement of internal camera components as well as the mounting base to optimize heat-sinking.

1.2.2 Optical Interface

The lens-to-camera interface is shown in Appendix B. The mounting tolerance of the flange provides a back working distance of approximately 1.522 inches as measured from the front surface of the FPA to the back of the mounting flange interface. The mounting tolerance of the flange provides a working distance of at least 0.329 inches as measured from the mounting flange interface to the front of the dewar window, in order to accommodate the insertion of a calibration flag into the optical path. The standard dewar f/number for the camera is f/2.5, and the aperture is 0.414 inches in diameter.

2 Getting Started

The Merlin Mid Camera is delivered completely assembled. The camera has been preset with four non-uniformity correction (NUC) tables for imaging scenes at room temperature and above. The FPA requires temperature stabilization in order to operate properly. This takes less than 10 minutes from power up (if the camera case is at 25 degrees C), and during the cool down time the image will appear non-uniform. Once a stable image appears, it is recommended that a one-point correction be performed in order to obtain a clear, uniform image.

2.1 Warnings and Precautions

The following warnings and precautions should be followed when handling and operating your Merlin Mid camera.

- Great care should be exercised with your camera optics. The antireflection coating on the germanium optics is very easily scratched and should only be cleaned according to the procedures outlined below. Otherwise, a light dusting of air should be enough to dislodge any dust particles, although small amounts of dust will not affect image quality noticeably. If it is absolutely necessary to clean the surface, use 75% isopropyl alcohol and lens tissue, and use extremely light wiping motions. Use a fresh section of tissue with each swipe so as not to drag a piece of dirt back over the lens surface.

- Do not open your camera body for any reason. The camera should only be serviced by Indigo Systems Corporation.

2.2 System Setup

To obtain an image with a video monitor, perform the following operations in order:

1. Connect the remote button panel to the back of the camera using the cable with the 15 pin connector on each end.
2. Connect the video output to a monitor using the BNC video cable.
3. Connect the 24 VDC supply to the rear panel power connector.
4. Switch the back panel power switch to the on position.

You should see a "white hot" monochrome image appear after about a 10 minute stabilization time. This is the default video setting. Refer to section 3.3.2.1 for other options. The camera will operate in Automatic Gain Control (AGC) mode when powered up. Push the Menu button on the remote button panel to access the menu selection. The menu should appear on the monitor. Use the arrow keys to move through the menus, pushing the enter button to execute commands. The camera has been set up at the factory to support imaging using the four NUC tables. The camera will default to NUC0 on power up, as this is considered the factory default NUC table. Camera parameters for NUC0, such as integration time, gain, detector bias and video offset can only be permanently changed (in flash memory) through the RS-232 interface, not through the button panel. Typical settings for NUC0 are:

Integration Time – 1.0 msec
Gain – 0
Vdetcom – 60
Vid_Offset – 182

2.3 Non-Uniformity Correction

Infrared detectors vary in their individual response to thermal or photon energy. This is commonly referred to as detector "non-uniformity". Unless some type of compensation is performed, this variation in response of the individual detectors will result in a non-uniform image. Non-uniform images appear "grainy" and unclear with possible black and/or white pixels apparent. The following narrative provides a brief description of how the correction process works, along with some representative correction methods and a tutorial on setting up the camera to perform a two-point correction. The non-uniformity correction process is sometimes (inaccurately) referred to as "calibration".

Note: Best results are achieved when the Merlin Mid FPA is allowed to reach temperature stability before applying non-uniformity corrections. A 30 minute stabilization period is usually sufficient after power up. The user can apply a correction as soon as an image appears after power up (~10 minutes, depending on camera case temperature), but should apply the correction again after the camera FPA has fully stabilized.

2.3.1 One-Point Correction

Improvements in detector fabrication and processing have resulted in detector gain values that are relatively stable over time. "Drift" is the term used to describe the gradual change over time of detectors from a uniform to a non-uniform state. In most cases where the camera parameters have not been changed, it is only necessary to perform an occasional offset correction, referred to as a one-point correction, to achieve a uniform image. This is done by filling the FPA's field of view with a uniform source of illumination. When commanded to perform a one-point correction, the camera will collect data from several successive image frames of this uniform source. From this data, offset correction values will be calculated for each pixel assuming that all the pixels are being illuminated with the same flux levels. The term one-point refers to performing this correction at a single temperature reference point, updating only the offset correction coefficients.

2.3.1.1 Internal One-Point Correction

After power up, performing a one-point correction should provide a good image for room temperature scenes. The command for performing a one-point correction is both located at the 1-PT button on the remote button panel and under the Calibration Menu. An internal motorized flag assembly is incorporated in the camera between the FPA and the camera lens. The camera is set up at the factory to use the internal flag source to perform one-point corrections. Upon sending a one-point command, the cal flag is automatically servoed in front of the FPA, image data is acquired and used to calculate the offset correction. The flag is at ambient temperature when it is performing a one-point correction.

2.3.1.2 External One-Point Correction

It is often desirable to use an external calibration source, as opposed to the internal flag, since any non-uniformities in the camera lens are then also corrected. When using an external source, the internal flag must be disabled through the RS-232 interface with the command MANFLAG.

In the MANFLAG (manual flag) mode, the user will be prompted to supply an external uniform temperature source for a one-point correction. When the one-point command is executed, the video monitor will display instructions for placing a correction source in the camera field of view. This source should be a uniform temperature, flat black source that covers the camera's field of view. Two black-painted metal plates are supplied with the camera for this purpose. The source should be placed close to the front of the lens and remain in place according to the instructions displayed on the monitor. The camera can be put back into internal flag mode with the software command DUALFLAG (see section 3.6.2.1). This is the factory default configuration. DUALFLAG refers to the dual temperature capability of the cal flag, explained in section 2.3.3.

2.3.1.3 One-Point Correction Commands

There are three varieties of one-point correction you can perform:

1. 1 Point Refresh – press the 1PT button. The camera does a one-point correction using the ambient internal flag or an external source, depending on whether the camera is set to manual flag mode. As the calculated coefficients are not stored in flash memory, this correction is lost if you subsequently change NUC tables or power-cycle the camera.

2. 1 Point Update – hold the 1PT button until the following messages are displayed:

   PERFORMING 1 POINT UPDATE CALIBRATION…
   ACQUIRING DATA…
   CALCULATING AND STORING COEFFICIENTS…

   This option stores the correction coefficients in flash memory. If you subsequently change NUC tables, and then return to the NUC table with the one-point update, the values are saved. You can also initiate a 1 point update by going to the CALIBRATE menu, then selecting 1_PT_UPDATE, then pressing enter.

3. Cal 1 point – this is a factory test function, which can be initiated only through the RS-232 port, and is intended for factory testing purposes only. Do not use it!

2.3.2 Two-Point Correction

Note: A two-point correction for each NUC table has been performed using high quality blackbody sources at the factory, so in most cases you will not need to repeat this process unless the integration time must be changed.

The most definitive NUC is referred to as a "two-point" or "gain and offset" correction. This type of correction is done by measuring the output voltage of each detector element at two temperature points that may be designated as "cold" and "hot". The temperature difference is relative, and depends on the application, but should be at least 10 degrees (a few hundred A/D counts). The average pixel response at the cold and hot temperatures is first determined. Gain and offset values, also called correction coefficients, are then calculated and applied to each

pixel so that the response of each pixel fits the slope of a line fitted through the cold and hot average points. The gain term is used to adjust the slope and the offset term is used to correct the DC level, both on a pixel-by-pixel basis.

During the two-point correction process "bad pixels" are identified and replaced using a nearest neighbor replacement algorithm. "Bad pixels" are identified based on a response and/or noise level outside a factory defined point from the mean response and noise level. The "bad pixels" are not replaced in the camera's 12-bit digital data output (unless the camera is set to DISPLAY_VID using the DIG_VID_OUT command in the CAM_SETUP menu, as described in Section 3.3.4.) Instead the camera sets the bad pixels' levels to 0, making it easy to apply a correction in the software that processes the digital data.

2.3.3 Internal Two-Point Correction

The Merlin Mid is equipped with a calibration flag that is automatically heated and cooled during a two-point correction in the factory default condition (DUALFLAG enabled). The flag temperatures are preset to 17 degrees C and 32 degrees C. To initiate a two-point correction using the dual-temperature flag, select the 2 PT menu function under the CALIBRATION menu. The camera will automatically cool the flag, acquire several frames of image data, then heat the flag, acquire several frames of image data, and calculate the gain and offset correction coefficients.

2.3.4 External Two-Point Correction

2.3.4.1 Hot and Cold Sources

The best non-uniformity correction results are usually achieved by using uniform temperature sources placed in front of the camera lens, as opposed to an internal flag between the lens and the FPA. Corrections performed through the lens take into account the entire optical path from the source to the FPA. In addition, the uniformity and temperature accuracy of external sources can be better controlled than with internal sources. This can give a superior corrected image, since reflections within the lens or other non-uniformities are corrected for as well. External cold and hot sources may be as rudimentary as a lens cap and a hand, respectively. Good results can be obtained using the factory-supplied black metal plates, leaving one plate at room temperature and the other on top of a computer monitor to provide a reasonable temperature differential. Advanced IR camera operators often use calibrated, very uniform temperature sources called blackbody sources.

When using external sources it is important that they be placed close to the front of the lens. Sources must cover the entire lens area so that the FPA "sees" nothing but the source itself. If these conditions are not met, then the FPA will be exposed to stray radiation and a one- or two-point correction process may be compromised.

The hot and cold sources used to perform the two-point correction should bound the temperature range of the scene of interest and be within 10 – 15% of the camera's dynamic range. Therefore, imaging the hot source should produce an output at least 10 % below the saturation level, while the cold source should produce an output at least 10 % above the bottom rail.

2.3.5 Setting Up for and Performing a Two-Point Correction

As stated previously, each of the camera's four non-uniformity correction (NUC) tables has been preset at the factory to image room temperature scenes. If these preset NUCs are not sufficient for your application the camera will need to be setup for the particular scene it will be imaging. The two-point correction needs to be done using the camera parameters for the particular scene. The integration time and video offset level are the two most important parameters to adjust (in a few cases the gain or even more seldom, the detector bias may need adjusting). These parameters are specific for each of the four NUCs. The parameters are adjusted using the remote button panel (or RS-232 interface) and selecting the CALIBRATION menu then selecting the INTG_TIME or VID_OFFSET menu. The arrow keys on the button panel increase/decrease the parameter values. The WAVEFORM command is also found under the CALIBRATION menu.

To maximize sensitivity of the Merlin camera, the longest possible integration time, which does not saturate the response, should be used, based on the minimum and maximum temperatures of interest in the scene to be imaged. The video offset level is required since the FPA has a larger range than the A/D converter. Adjusting the VIDOFFSET allows the FPA's range to be adjusted within the A/D converter's range (0-4095 counts) The VIDOFFSET range is 0 to 255 where 0 sets the camera to the lowest part of the FPA range. To adjust the VIDOFFSET range, turn on the WAVEFORM trace. Increasing the VIDOFFSET value will cause the level of the output displayed by the WAVEFORM to move down since the camera is being adjusted to use the upper portion of the focal plane array's range.

The basic method used to set up the integration time and video offset level is to iteratively adjust these parameters by trial and error, keeping the FPA's output signal within the range of the A/D converter for all scene temperatures of interest. As an example, assume that the minimum and maximum temperatures of interest are 10 and 50 degrees Celsius. An ideal setup for this case would be if the 10 degree object produced an A/D converter value of 400-500 counts while the 50 degree object gave a value of 3500-3600 counts. (The A/D converter's range is 0-4095). The following steps outline the procedure for setting up and performing a two-point normalization. A detailed description follows:

1) Be sure the FPA is at a cold stable temperature.
2) Initialize the NUC table to be used.
3) Enable the WAVEFORM function.
4) Set the GAIN and VDET_ADJ to the factory default settings
5) Determine the bounds for the video offset and upper bound for the integration time.
6) Optimize the video offset and integration time settings for the scene temperatures of interest.
7) Perform the two-point normalization
8) If unsuccessful, check for the cause and perform the normalization again.
9) (Periodically perform 1-point normalizations).

Select the NUC to be used by pushing the NUC button on the remote button panel to scroll through the four NUC settings. To activate the desired NUC, push the enter button within a few seconds of scrolling to that NUC. Do not select NUC 0 since this is the factory default setting and can only be overwritten through the RS-232 interface. Note that the NUC button only works when the camera menu display is not active. Once the NUC is selected, push the MENU button

to activate the camera menu, select the CALIBATION menu using the arrow keys then pushing the enter button to enter this command. Under the CALIBRATION menu, select the NUC_INIT function, push the enter button to execute this command. This command sets the camera so that the output appears as if the current NUC table has been initialized, setting all the gain coefficients to a value of 1 and all the offset coefficients to a value of 0. The bad pixel map is also cleared. Once the NUC has been initialized, the image should appear grainy with black and white pixels apparent. Performing a two-point correction will reset the gain and offset coefficients to the appropriate values. A bad pixel map is also generated during the two-point normalization.

The camera's WAVEFORM function (under the Calibration menu) should be enabled for determining the output level produced by a given scene. When enabled a waveform trace will appear across the bottom third of the video display. This waveform display allows the user to view the output of the FPA in an "oscilloscope" fashion. Each point on the waveform display is the average of a row of FPA pixels. Each waveform point thus represents the average of the 320 pixels comprising an FPA row and 240 such points are shown horizontally across the display where the right most point on the display represents the average of the top row of FPA pixel values. If the waveform trace is near the bottom of the display this means the FPA signal is in the lower part of the A/D converter range (~ 0) and if the trace is near the top of the display the FPA output is near the top of the A/D converter's range (~4095). In order for a two-point normalization to work well, almost all the pixels on the FPA should not approach the zero level when looking at the cold source, nor should they approach the 4095 level when imaging the hot source.

Under the CALIBRATION menu check the values set for the GAIN_STATE and DET_BIAS. In almost all cases these parameters should remain at the factory default settings. The GAIN_STATE should be set to 0 and the DET_BIAS to ~64. Check the camera configuration sheet delivered with your camera for the exact settings.

Under the CALIBRATION menu, select the INTG_TIME function and set it to the minimum value of 10 microseconds. Place the camera so that the 10 °C source is in the camera field of view. The AGC can be on or off during this procedure, it does not affect the results. Now select the VID_OFFSET function, also under the CALIBRATION menu. Use the arrow keys on the button panel to adjust the VID_OFFSET level so that the waveform trace is about 10% above the bottom rail when imaging the 10 °C source. Make a note of the VID_OFFSET level.

Now set the VID_OFFSET level to a high value, (~150) and place the 50 °C source in the camera field of view. Increase the integration time until the waveform trace reaches the top of its display range (the A/D converter saturates), or the trace no longer moves up as the integration time is increased (the FPA saturates). From this maximum point, decrease the integration time until the waveform trace is 10% below the maximum point. You have now bracketed the VID_OFFSET and INTG_TIME values that may be used for the selected scene temperatures. The effect of adjusting these parameters has also been demonstrated.

The next step is to iterate the VID_OFFSET and INTG_TIME settings while imaging the two scene temperatures until you have found the values that give the largest signal difference between the two temperatures and while keeping the signal level within the 10-90% range on the

waveform display. If the temperatures you are imaging are fairly close together and you cannot get a reasonable signal level difference without the integration time being so long it saturates at the high temperature, use the VID_OFFSET level to center the range of the signals. Then try increasing the GAIN_STATE to a value of 1. This may or may not cause the signal to go off scale at either temperature. If the signal goes off scale at one end, try adjusting the VID_OFFSET level so that both the high and low temperature output levels remain in the waveform's 10-90% range.

2.3.5.1 Two-Point Correction Procedure

Once the INTG_TIME (and other NUC parameters) have been set, you can perform the external two-point correction. Set the flag to MANFLAG via the RS-232 COM port. Select the 2_PT menu function (under the CALIBRATION menu). Have your cold and hot sources ready to place in front of the camera. Follow the directions on the video monitor for placing the cold and hot sources in place. Note that when the camera is performing a one or two-point correction, the output trace of the WAVEFORM is not active, and the hot and cold sources should be checked prior to initiating the correction process.

Sequence of Events:

- The camera will prompt you to put the cold source in place.
- Press the enter button to begin executing the two-point correction.
- The camera automatically adjusts the offset so that response looking at the cold source is one quarter full scale (~1000 counts).
- The camera takes the cold data.
- The camera prompts you to put the hot source in place.
- The camera takes hot data, and performs the NUC table computations.
- While looking at the hot data, the camera looks for noisy pixels and marks them as bad.
- Once the two-point correction is complete, a status menu appears on the display for a few seconds. This shows the A/D converter levels for the cold and hot sources along with the number of bad pixels found during the correction process. You may want to note these values.

If the difference between the cold and the hot source was not sufficient (typically at least a few hundred counts) a message will appear on the video display stating the correction failed due to the "delta" in temperature being too small. The two-point should be repeated with sources that provide a larger difference in signal level. It is recommended to place the sources in the camera field of view and check the waveform level prior to initiating the 2_PT command. The waveform trace should change by at least 1/10 of the range.

If the correction is successful the image should appear uniform and clear. Upon completion of a 2_PT correction, the camera parameters (Integration time, Detector Bias, Gain, Video Offset) are stored in the camera flash memory until another 2_PT is performed on this NUC.

After completion of a two-point correction if the image appears black or very blotchy the two-point correction was unsuccessful. Probable causes for the failure are:

1) Sources did not completely cover the camera field of view during the entire data collection period, particularly if there is a large portion of the image that is black or white.
2) The FPA is not at a stable temperature.
3) One of the sources came too close to or was outside the A/D converter's range.
4) Incorrect camera NUC parameters were used.

Even if a two-point correction is successful and results in a good looking image, a grainy effect will appear when imaging scenes in which the temperature of objects is far outside the range over which the two-point correction was performed. A correction for the higher temperature conditions should be performed for imaging these scenes.

Following a successful two-point correction, there will be some drift in the output of the pixels, especially following warm-up/cool down cycles of the FPA. This drift will appear as slight graininess in the image; sometimes a few black or white pixels will also appear. These effects can almost always be corrected by performing a one-point correction, often referred to as an "offset correction" since only the offset coefficients in the NUC table are updated during this process. A single temperature source is used for this correction. Experience with systems such as the Merlin Mid camera has shown that for a given set of camera parameters, a one-point correction is sufficient for periods of several months or longer.

Note: If you want to be able to perform 2-Point corrections using the internal flag, be sure to reset the flag to DUALFLAG using the RS-232 COM port.

3 Camera Control

The Merlin Mid Camera can be controlled through the remote button panel or the RS-232 serial port interface using the Graphical User Interface software or a terminal mode program such as HyperTerminal. The commands accessible through the remote button panel are a subset of the commands that can be entered through the serial port, and it will be necessary to use the RS-232 interface in order to access advanced camera features. A complete list of camera commands is given in Appendix A.

3.1 Remote Button Panel Control

This chapter describes how to use the remote button panel to control the camera system and perform functions such as changing FPA settings, performing corrections, adjusting contrast and brightness, and checking camera status.

The button panel interface consists of two Camera Status LED's and 13 Camera Control Buttons. The two Camera Status LED's function as follows:

Automatic Gain Control (AGC) LED:	On - AGC Enabled Off - AGC Disabled
Power LED:	On - Input Voltage Level is OK Off - Input Power Not Applied Flashing - Input Voltage is Low
Flashing Power & AGC LEDs:	Boot Error or System Error has Occurred.

Note: A low input voltage may indicate a bad power supply or a power input connector that is not properly mated.

Note: If restarting the camera does not fix the boot error, contact Indigo Systems Corporation. Your camera may need service.

The 13 camera control buttons on the remote button panel are shown in Figure 1. A description of their functions is listed below:

Menu: This displays the camera control menu in the upper symbology window and places the cursor (highlighted item) in the most recently selected position. Pressing the <*MENU*> button, while in the camera control menu, will cause the upper symbology window to be cleared. While in a submenu, pressing the <*MENU*> button will display the camera control menu and place the cursor (highlighted item) in the most recently selected position.

Enter: Enters the sub-menu or activates the highlighted operation when the cursor is present. If no cursor is highlighted (typically in a numeric increment/decrement menu), then pressing the <*ENT*> key will return the display to the next higher menu. If no menu is present pushing this button toggles the video polarity.

Contrast Up: Increases the contrast level when the AGC is not active, turns the AGC off if the AGC is active.

Contrast Down: Decreases the contrast level when the AGC is not active, turns the AGC off if the AGC is active.

Brightness Up: Increases the brightness level when the AGC is not active, turns the AGC off if the AGC is active.

Brightness Down: Decreases the brightness level when the AGC is not active, turns the AGC off if the AGC is active.

Once the menu is displayed these buttons are used to select sub-menu items.

Note: The Zoom in/out and Focus in/out functions indicated on the Navigator buttons are not implemented for the Merlin Mid camera.

Navigator Right: Moves the cursor "across to the right" within a row (if the cursor is already at the far right, it will roll over to the left most item).

Navigator Left: Moves the cursor "across to the left" within a row (if the cursor is already at the far left, it will roll over to the right most item).

Navigator Up: Moves the cursor "up" within a column (if the cursor is already at the top of a column, it will roll over to the bottom item).

Navigator Down: Moves the cursor "down" within a column (if the cursor is already at the bottom of a column, it will roll over to the top item).

AGC Enable: Enables the camera automatic gain and level control. The AGC led will turn on when AGC is enabled.

1 PT: Pressing this button perform a one-point refresh correction. A one-point refresh uses the internal flag if the camera is set to DUALFLAG mode (factory default), or else prompts the user for a reference source if set to MANFLAG mode. The camera averages eight frames of reference video, then determines new NUC offset values for each FPA pixel (while maintaining the existing gain coefficients) and new offset coefficient values are loaded into the camera hardware.

NOTE: The one-point refresh correction operation does not change the contents of the NUC flash memory.

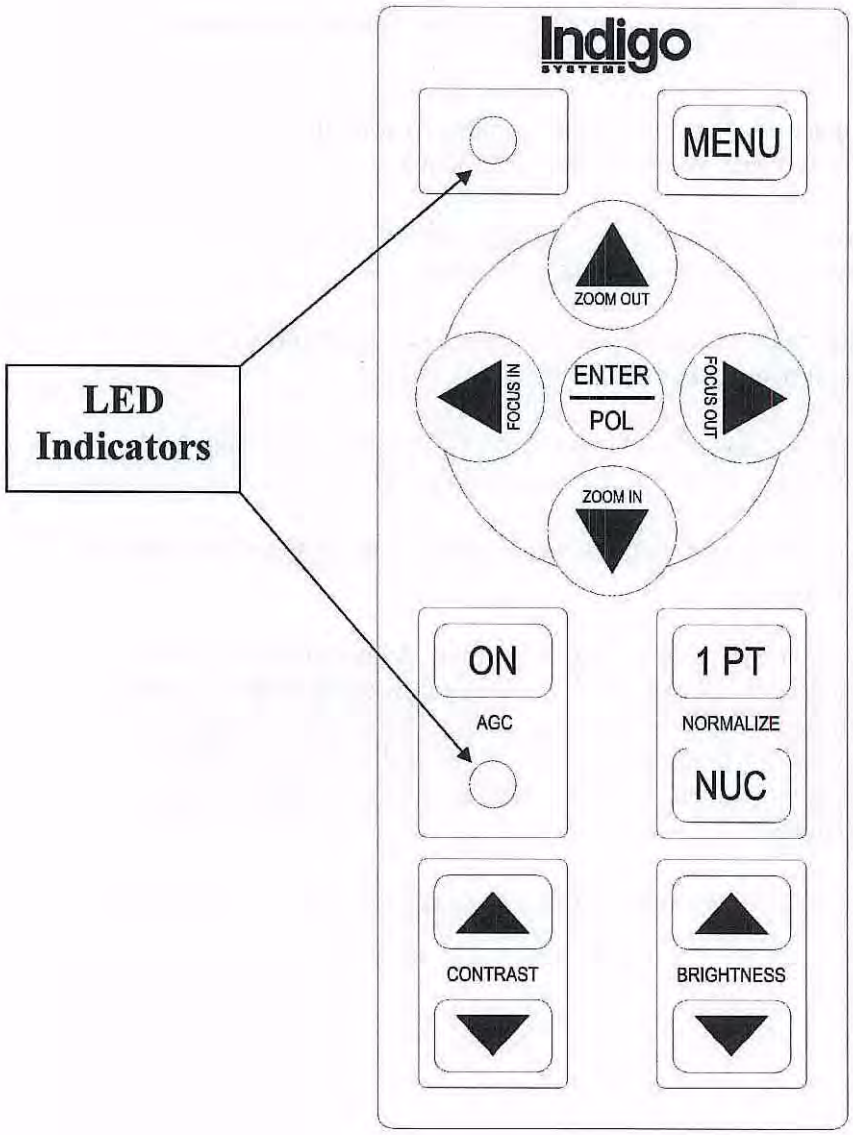


Figure 1. Button Panel Layout

NUC Select: Selects a non-uniformity correction table. Keeping the button depressed cycles through the three NUC tables and pressing enter within a few seconds of cycling to a NUC will enable that NUC.

ROM Boot: The button panel also supports a ROM boot operation by simultaneously pressing the Menu and Navigator Right keys at power up. This sets the camera back to NUC0 and restores the RAM memory from the flash memory. See Section 3.4.2.

3.2 Menu Overview

The Camera Control Main Menu consists of the following selections:

CALIBRATE
DISPLAY
AGC_SETUP
CAM_SETUP

3.3 Menu Descriptions

3.3.1 CALIBRATE Submenu

The CALIBRATE submenu allows the user to setup the FPA and to perform either a one-point update or two-point correction. The CALIBRATE submenu consists of the following selections:

CALIBRATE	1_PT_UPDATE	GAIN_STATE
NUC: x	2_PT	DET_BIAS
	WAVEFORM	VDETCOM
	INTG_TIME	2X_ZOOM
	VID_OFFSET	NUC_INIT

Where x is the currently active NUC table.

3.3.1.1 1PT_UPDATE Function

The 1PT_UPDATE selection allows the user to perform a one-point update correction. The one-point update correction routine prompts the user to place a reference into the sensor field-of-view, averages 16 frames of reference video, determines new NUC offset values for each FPA pixel (while maintaining the existing gain coefficients) and loads the new coefficient values into the camera hardware. The one-point update correction operation stores the new NUC coefficient tables in the NUC flash memory at the active NUC table index. The current FPA mode parameters are also saved into flash memory for restoration during a NUC table switch.

The 1PT_UPDATE function requires a two-point NUC table to be present before correction will continue. The 1PT_UPDATE function will prompt the user for permission to overwrite the "factory" table (NUC 0).

Note: The 1PT_UPDATE function will either use the internal flag or ask for an external source, depending on whether DUALFLAG is enabled (internal flag), or MANFLAG is enabled (external source).

3.3.1.2 2_PT Function

The 2_PT selection allows the user to perform a two-point correction. The two-point correction routine prompts the user to place a "cold" reference into the sensor field-of-view, performs a successive approximation analog pixel offset coefficient generation procedure, averages 16

frames of "cold" reference video, prompts the user to place a "hot" reference into the sensor field-of-view, averages 16 frames of "hot" reference video, determines new NUC offset and gain values for each FPA pixel and loads the new coefficient values into the camera hardware. Following NUC coefficient generation, the two-point correction routine automatically detects noisy pixels (4 passes) and performs a defective pixel replacement procedure which masks non-responsive and noisy pixels with the nearest neighboring functional pixel. The two-point correction operation stores the new pixel offset and NUC coefficient table into the NUC flash memory at the active NUC table index. The current FPA mode parameters are also saved into flash memory for restoration during a NUC table switch. A summary of cold average, hot average, noisy pixels and total bad pixels is reported in the upper symbology window at the conclusion of the two-point correction process.

Results of each pass of the two-point correction, including the noisy pixel detection process (4 total passes) are always reported on the COM0 port. The 2PT function for NUC0 must be accessed from the RS-232 COM port. The 2PT function will prompt the user for permission to overwrite the "factory" correction table (NUC 0).

Note: The 2_PT function will either use the internal flag or ask for external hot and cold sources, depending on whether DUALFLAG is enabled (internal flag), or MANFLAG is enabled (external source).

3.3.1.3 WAVEFORM Function

The WAVEFORM function allows the user to either enable or disable the waveform display window on the lower symbology screen. The waveform display allows the user to view the output of the FPA in an "oscilloscope" fashion in order to adjust FPA mode parameters for desired operation. Each point on the waveform display is the average of a row of FPA pixels. Each waveform point thus represents the average of the 320 pixels comprising an FPA row and 240 such points are shown horizontally across the display where the right most point on the display represents the average of the top row of FPA pixel values.

When disabled, the lower symbology screen shall be returned to the previous status display state.

3.3.1.4 INTG_TIME Function

The INTG_TIME function is used to change the FPA integration time, which can be varied from 10 microseconds to 16.6 milliseconds. Use the *<NUP>* button to increase the value or the *<NDN>* button to decrease the value. The integration time will change in 0.1 millisecond increments for integration times greater that 1 millisecond and will change in 10 microsecond increments for integration times less than 1 millisecond. The integration time value is updated in the mode structure but will not be permanently saved in FLASH unless a one-point, one-point update or two-point correction is performed.

3.3.1.5 VID_OFFSET Function

The VID_OFFSET function is used to change the FPA video offset voltage. The FPA has a larger range than the A/D converter so adjusting the VID_OFFSET allows the FPA's range to be adjusted within the A/D converter range. The VID_OFFSET range is 0 to 255 where 0 sets the camera to the lowest part of the FPA range. Use the *<NUP>* button to increase the value or the *<NDN>* button to decrease the value. To adjust the VID_OFFSET range, turn on the WAVEFORM trace. Increasing the VID_OFFSET value will cause the level of the output displayed by the WAVEFORM to move down since the camera is being adjusted to use the upper portion of the focal plane array's range. See the Non-Uniformity Correction Section (Section 2.3) for more details on setting the VID_OFFSET level.

The VID_OFFSET factor value is updated in the mode structure but will not be permanently saved in FLASH unless a one-point, one-point update or two-point correction is performed.

3.3.1.6 GAIN_STATE Function

The GAIN_STATE function allows the user to adjust the FPA gain state value (0 – 3). Use the *<NUP>* button to increase the value or the *<NDN>* button to decrease the value. The GAIN_STATE factor value is updated in the menu structure but will not be permanently saved in FLASH unless a one-point, one-point update or two-point correction is performed.

This setting adjusts the focal plane column amplifier gain. The four possible gain states are listed in Table 1.

GAIN	$\mu V/e^-$	Relative Signal Gain	Max e^- x 10^6
0	0.17	1 (default)	18
1	0.22	1.33	13.5
2	0.33	2	9
3	0.60	3.8	4.7

Table 1. Amplifier Gain States

*Assumes 77 K operating temperature

3.3.1.7 DET_BIAS Function

The DET_BIAS function allows the user to adjust the FPA detector bias adjust value (0 – 127). Use the *<NUP>* button to increase the value or the *<NDN>* button to decrease the value. The DET_BIAS factor value is updated in the mode structure but will not be permanently saved in FLASH unless a one-point, one-point update or two-point correction is performed.

The range 0-127 corresponds to setting bits of the ROIC Serial Control Register field DE(6-0) that controls the bias across the detector. Setting DET_BIAS to 0 (0000000) corresponds to the

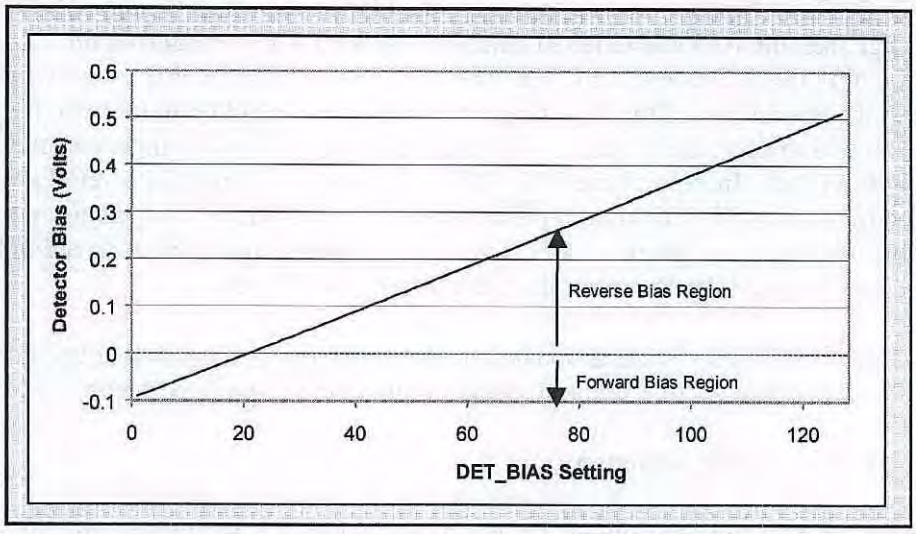


Figure 2. Detector Bias Settings

maximum forward bias condition. Setting DET_BIAS to 127 programs the DE(6-0) field to (1111111) setting the detector input bias to the maximum reverse bias condition. The finest adjustment resolution using the Serial Control Register settings is ~4.8mV per bit with a maximum adjustment range of ~610mV. Figure 2 shows the bias across the detector vs. the DET_BIAS setting (0-127) for I_{PH} (photo current) =100pA, I_{DK} (dark current) =18pA, and R_{DET}=2.2e9 □.

3.3.1.8 VDETCOM Function

The VDETCOM function is not enabled in the Merlin Mid Camera. The VDETCOM bias is set to 5.5 volts for InSb detectors since this provides plenty of reverse bias across the detector. The VDETCOM function is used for high reverse bias detectors such as QWIPs.

3.3.1.9 2X_ZOOM Function

The 2X_ZOOM function allows the user to enable or disable the "line repeat" FPA mode feature. When activated, this function places the FPA into a 2X electronic zoom mode. When in the 2X-zoom mode, the camera operates from the central 160 by 120 pixel (NTSC) or 160 by 128 pixel (PAL) region of the FPA. The 2X_ZOOM factor value is updated in the mode structure but will not be permanently saved in FLASH unless a one-point, one-point update or two-point correction is performed.

3.3.1.10 NUC_INIT Function

The NUC_INIT function sets the camera so that the NUC correction factors are bypassed, giving the appearance that the gain coefficients are set to one and the offset coefficients to zero. The user will be prompted to insure that a NUC initialization operation is desired before executing the initialization process.

Note: The NUC_INIT function does not change the FLASH memory. Activating a new table from the button panel will restore the NUC settings.

3.3.2 DISPLAY Submenu

The DISPLAY submenu allows the user to setup the camera display screen. The DISPLAY submenu consists of the following selections:

DISPLAY	VID_PALETTE	COLOR_BAR
	TEXT_COLOR	
	STATUS	
	XHAIR_0	
	XHAIR_1	

3.3.2.1 VID_PALETTE Function

The VID_PALETTE function is used to change the color scheme of the FPA video on the display screen. The user may select either monochrome, gamma corrected monochrome, or from eight false color tables (1 through 8). The following VID_PALETTE submenu will be displayed upon activation:

VID_PALETTE	MONO_G1.0	NO_GREEN
	MONO_G2.2	NO_YELLOW
	RED_HOT	RAINBOW
	SEPIA	SPARE_0
	FUSION	SPARE_1

3.3.2.2 TEXT_COLOR Function

The TEXT_COLOR function is used to change the color scheme of the FPA symbology on the display screen. The user may select either monochrome or from three different color tables (A thru C). The following TEXT_COLOR submenu will be displayed upon activation:

TEXT_COLOR	MONO
	COLOR_A
	COLOR_B
	COLOR_C

Note: See Section 3.7 for a table of color values for the symbology.

3.3.2.3 STATUS Function

The STATUS function is used to control the status window in the lower symbology screen. The user may disable the status display, enable full status or show date and time only. The STATUS function also allows the user to set the date and time for the camera. The following STATUS submenu will by displayed upon activation:

STATUS	OFF
	ON
	DATE_TIME
	SET

To completely disable the status display, activate the OFF menu selection. Note that even when the status window is disabled, the low power indicator will flash in the lower symbology screen when a low voltage condition is detected.

To enable the full status display, activate the ON menu selection. This full status display will show the following items on the lower symbology screen:

AGC:	LIN/HISTO/LIN2/OFF
BRT:	Brightness in % of full scale
CON:	Contrast in % of full scale
ROI:	Region of Interest for AGC/ALC Calculations (16K, 32K, 64K)
NUC:	Active NUC Table
ASW:	Auto NUC Switch OFF or ON (Always OFF in version 2.02)
POL:	NORM (White Hot) / INV (Black Hot)
DIG:	Format of Digital FPA Video Data Output (Uncorrected, Corrected, AGC/ALC Pixel Replaced)
INT:	Integration Time (Reported in Microseconds)
GAN:	FPA Gain State (0, 1, 2 or 3)
RPT:	Line Repeat OFF or ON
TYP:	FPA Type that installed software supports (I002 in version 2.02)
CFG:	Configuration code
SER:	Serial number of unit
PRM:	Current EEPROM Version
S/W:	Software revision
PWR:	OK/LOW Status of input power
	Current Date and Time

To enable the partial status display, activate the DATE_TIME menu selection. This enables a partial status display wherein only the current date and time are displayed in the lower symbology screen.

To change the time and date, activate the SET menu selection. This will display the following menu along with the current values for hours, minutes, month, day, and year:

SET	HOURS
	MINUTES
	MONTH
	DATE
	YEAR

To update any of the date/time values, activate the appropriate menu selection. Use the *<NUP>* button to increase the value or the *<NDN>* to decrease the value. When you are finished changing a particular field, press the *<ENT>* button to return to the SET submenu. When done

changing all required date/time fields, press <*MENU*> to update the date/time in the camera real-time clock circuit and return to the main menu.

3.3.2.4 XHAIR_0/XHAIR_1 Functions

The XHAIR_0/XHAIR_1 functions allow the user to control the two hardware cross-hair generators in the camera. The user can control the location and size of the two cross hairs. The following XHAIR_x submenu will be displayed upon activation:

XHAIR_x	OFF
	ON
	LOCATION
	SIZE

To disable the cross hair, activate the OFF menu selection. To enable the cross hair, activate the ON menu selection.

Activate the LOCATION menu selection to control the crosshair locations. With the LOCATION menu item selected, the navigator buttons (<*NUP*>, <*NDN*>, <*NRT*> and <*NLT*>) control the position of the cross hair on the display. Hold the appropriate navigator button to move the cross hair in the desired direction. The horizontal and vertical position of the cross hair will be displayed while the LOCATION menu item is active. When done changing the location, press the <*ENT*> button to return to the XHAIR_x submenu or press <*MENU*> to return to the top-level menu.

To change the size of the cross hair, activate the SIZE menu selection. Use the <*NUP*> button to increase the value or the <*NDN*> to decrease the value. When done changing the size, press the <*ENT*> button to return to the XHAIR_x submenu or press <*MENU*> to return to the top-level menu.

3.3.2.5 COLOR_BAR Function

A thin band running horizontally across the top of the screen appears when the COLOR_BAR function is enabled. This band represents the full spectrum of the color palette currently in use, or in the case of a monochrome palette selection, the full gray scale.

3.3.3 AGC_SETUP Submenu

The AGC_SETUP submenu allows the user to setup the camera display screen. The AGC_SETUP submenu consists of the following selections:

AGC_SETUP	AGC_TYPE
	ROI_SIZE

3.3.3.1 AGC_TYPE Function

The AGC_TYPE function allows the user to select the automatic gain and level control mode for the camera. The following AGC_TYPE submenu will be displayed upon activation:

AGC_TYPE LINEAR
HISTO_EQUAL
LIN_2_PART

To change the current AGC mode, activate the desired selection.

3.3.3.2 ROI_SIZE Function

The ROI_SIZE function allows the user to select the region-of-interest size over which to compute automatic gain and level control statistics. The following ROI_SIZE submenu will be displayed upon activation:

ROI_SIZE 16K
32K
64K

To change the current region-of-interest size, activate the desired selection. The region-of-interest size is selected in image pixels and the region-of-interest is centered in the camera field-of-view. There is not a symbology overlay box to display the selected ROI_SIZE.

3.3.4 CAM_SETUP Submenu

The CAM_SETUP submenu allows the user to setup the camera display screen. The CAM_SETUP submenu consists of the following selections:

CAM_SETUP DIG_VID_OUT
SYNC_MODE
ROW_ORDER
COL_ORDER
FACT_DEF

3.3.4.1 DIG_VID_OUT Function

The DIG_VID_OUT function allows the user to select the type of digital video output onto the camera's 12 bit digital data output port. The following DIG_VID_OUT submenu will be displayed upon activation:

DIG_VID_OUT UNCORRECTED
NUC_CORR
DISPLAY_VID

To set the digital output video to a particular format, activate the desired selection. The UNCORRECTED entry outputs 12-bit uncorrected video (no defective pixels replaced, marked a 0) onto the digital output port. The NUC_CORR entry outputs 12-bit corrected video (no defective pixels replaced, marked a 0) onto the digital output port. The DISPLAY_VID entry

outputs 8-bit corrected, contrast adjusted, defective pixel replaced video onto the digital output port. This function does not affect the data output on the NTSC (PAL) or S-Video outputs.

3.3.4.2 SYNC_MODE Function

The SYNC_MODE function allows the user to select either internal or external frame synchronization for the camera. The following SYNC_MODE submenu will be displayed upon activation:

SYNC_MODE INTERNAL
EXTERNAL

To set the synchronization mode video to a particular value, activate the desired selection. The INTERNAL mode uses the timing generator within the camera for display frame synchronization. The EXTERNAL mode requires an external sync (i.e. 29.97 Hz NTSC or 25.00 Hz PAL square wave) for display frame synchronization. See Section 4.2.1.3 for more information on external synchronization.

3.3.4.3 ROW_ORDER Function

The ROW_ORDER menu allows the user to toggle between normal or flipped FPA row readout order. The following ROW_ORDER submenu will be displayed upon activation:

ROW_ORDER NORMAL
FLIPPED

Use the *<NUP>* or *<NDN>* buttons to highlight the desired selection. Press *<ENT>* to activate the selection. Figure 3 shows the pixel output order for the various ROW and COLUMN ORDER modes. The lowest left-hand pixel is defined as pixel (0,0), where this annotation signifies the pixel at location row 0, column 0 of the ISC9705 device. Pixel (0,0) is the first pixel to be read out in the single output mode using normal settings for the row and column order. This mode of operation is chosen for a normal 'inverting optic'. Given this type of optic, a 'normal' raster scan image will be presented by placing the bottom row (row 0) at the 'bottom' of a camera system.

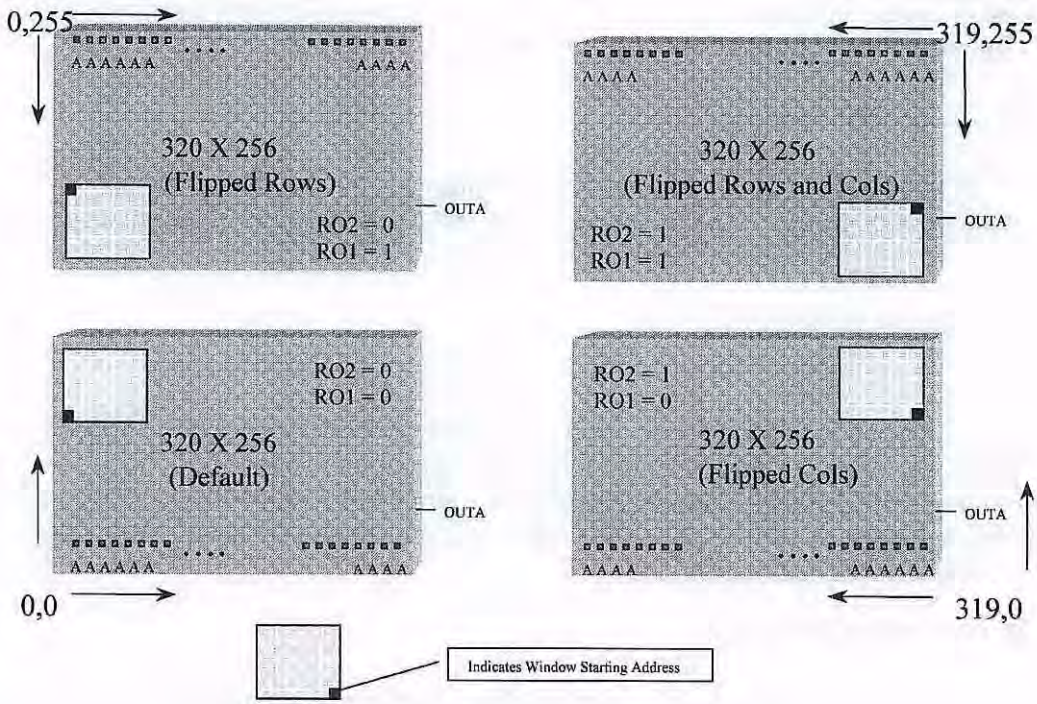


Figure 3. Single Output Mode Readout Order for Various Row and Column Orders

3.3.4.4 COL_ORDER Function

The COL_ORDER menu allows the user to toggle between normal or flipped FPA column readout order. The following COL_ORDER submenu will be displayed upon activation:

COL_ORDER NORMAL
FLIPPED

Use the *<NUP>* or *<NDN>* buttons to highlight the desired selection. Press *<ENT>* to activate the selection. See Figure 3.

3.3.4.5 FACT_DEF Function

The FACT_DEF function sets the camera to NUC255, an invalid state. Pressing the NUC button returns the user to NUC0, the factory default table. If the parameters for NUC 0 had previously been changed via the RS-232 interface and a 2 point correction performed, the FACT_DEF command returns to these most recent settings.

After initiating this command the AGC will be turned off.

3.4 RS-232 Serial Interface

Merlin accepts remote control functions and provides operating status via an RS-232 serial interface. A straight-through RS-232 cable should be connected between the RS-232 connector

on the camera back panel and the appropriate COM port on the computer. The camera is capable of transmitting and receiving serial data for distances up to 50 feet.

Note: A null modem serial cable will not work, as it is wired differently than a straight-through serial cable.

The camera can be remotely controlled through the RS-232 serial port using either a terminal program (e.g. HyperTerminal) or the Graphical User Interface software provided with the camera.
The PC-based graphical interface application runs under Windows NT through the RS-232 port. This software program is supplied with each camera that contains the executable and any necessary support files needed for remote camera control. An exception to this requirement may be a subset of camera commands for which Indigo may decide to charge a premium. In this event, selected camera commands are made available by means of a software-based password protection scheme or other method that does not require the return of the camera to the factory.

The terminal mode program should be configured as follows:

3.4.1 COM Port Connection Properties

To operate the camera through the RS-232 port, select the appropriate COM port and settings.

Port Settings:

Baud: 38400
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

COM Port Properties - Settings:

Function, Arrow, Control Keys – terminal keys
Emulation – VT100
Backscroll buffer lines - 500

ASCII Setup:

ASCII Sending – disable "send line ends with line feeds"
- disable "echo typed characters locally"
ASCII Receiving – enable "append line feeds to incoming line ends"
- enable "wrap lines that exceed terminal width"

The camera default baud rate is 38.4K baud. Symbology is overlaid on the video monitor and contains information regarding the status and operational modes of the camera. The camera supports field updates of camera application software or Xilinx FPGA configuration files, uploaded using the terminal mode program.

The COM0 serial port is fully functional (without user intervention) shortly after a power cycle or reset has been performed. This can be verified by connecting the terminal software before resetting the hardware. After a reset the camera outputs the following strings:

FORMAT NTSC *(or PAL)*
EXPANSION FLASH PRESENT *(if so configured)*
INSTRUMENTATION ADC PRESENT *(if so configured)*
BEGIN MAIN LOOP

This process takes approximately 5 seconds. Commands may be entered after this point in the boot up process. The terminal mode operation supports a basic command set, advanced command set and serial packet protocol interface (this interface requires a separate "front end" software application to be developed by the end user to meet specific requirements). A summary of the basic commands is provided in Section 3.6.1.

3.4.2 COM Port File Upload

A file upload for the purpose of updating the application software or Xilinx FPGA configuration files can be performed as follows:

a) Connect external computer running communications software to the camera's COM0 port.

b) Power up the system (or reboot) while simultaneously holding down the *<MENU>* and *<NRT>* buttons on the button panel, or wait until the camera has completed the boot up sequence and type the "PROGRAM" command via COM0.

c) The camera will output the following message -

> INPUT ACTION OR FILE TYPE TO BE LOADED
> (1) RESTORE CAMERA TO FACTORY DEFAULTS
> (2) CODE UPGRADE
> (3) XILINX UPGRADE
> (X) CONTINUE WITHOUT ACTION

d) Enter '1' to boot the hardware and reset the values in non-volatile memory and mode configuration structure to factory defaults. Choose '2' for code update, '3' for Xilinx FPGA update, or 'X' to continue without any action. If the COM port does not receive one of these characters it will retransmit the message and wait for user action.

e) Once a selection has been made for upload then use the communications software to send the proper file using the XMODEM-CRC format. This is a 128 byte per packet format with a cyclic redundancy check. The camera system will send the start download character ('C') approximately every 5 seconds until transmission begins.

f) After completion of file transmission the camera electronics will write the data to its FLASH memory. If a Code Update is performed, the upload message is output again for the purpose of complete board programming. After a Xilinx file is uploaded the system will continue with the booting process.