Technical Report for PoCL Standard Proposal

（PoCL 技術検討報告書（英語版））

Aug.29.2006　名雲　文男
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この文書は PoCL 規格案の付属文書として用意した二つの技術報告書のうちの一つです。（注1）

PoCL 規格書（案）は規格のみを記載しております。同規格の背景や根拠を理解するには第一の付属文書 Technical Note と、この第二の文書 Technical Report が有効です。

第一の付属文書 Technical Note は PoCL 技術の実現性や妥当性を定量的根拠に基づいて説明しております。 一方この第二の文書 **Technical Report** は PoCL 技術検討や実験結果を記したもので、第一の付属文書である Technical Note の裏づけ資料となります。

また、この文書には　PolySW 回路や電源雑音対応 LPF など、PoCL 規格検討に供された回路を具体例として記載しましたので、参考例としてご覧下さい （注2）。

注1：この文書は PoCL 規格（案）Ver.3.0 向けに作成しております。 従いまして、正規の PoCL 規格や、同時掲載の PoCL 規格（案）Ver.4.1 との間に僅かながら違いがある可能性がありますので、その旨ご注意願います。

注 2：この文書に記載の PolySW 回路や電源雑音対応 LPF などの具体回路例は、あくまで参考資料であり、規格を満たすものとしてその性能を保証するものではありません。

Technical Report for PoCL feasibility study

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PoCL Technical Report 1
Fast Transient Burst Test

Feb.08, 2006

CIS Corporation Ikuo Baba, Hisao Kawamura
Hitachi Kokusai Electric Inc Katsumasa Ueno
TOSHIBA TELI CORPORATION Koichi Yamakawa

Objective:

1. To evaluate the difference of the extraneous noise immunity of the PoCL System with 2 Drain Wires compared to the Camera Link System with 4 Drain Wires.
2. To evaluate the difference in extraneous noise immunity of the PoCL System with Camera GND 0.5V offset compared to the Camera Link System with no Camera GND offset.

Conclusion

The test showed there is no remarkable difference of immunity of the PoCL System from Camera Link system, as the result, there is no indication of the influences of the drain wire reduction and the Camera GND offset 0.5V.

Measurement method

Measured system（Fig.1）

Measured camera

Camera Link : VCC-G32U21CL

PoCL camera : VCC-G32U21CL Modified (Fig1.)

PoCL camera are added two adjustment resister, one is to make C-GND offset (Vd) of PoCL camera 0.5V and the other one is to make camera power consumption 4W.

The result of the test

Applied Fast Transient Burst level

±1kV : No trouble on the output picture quality, synchronization.

The System doesn't stop

±2kV : No trouble on the output picture quality and horizontal synchronization.

The System doesn't stop.

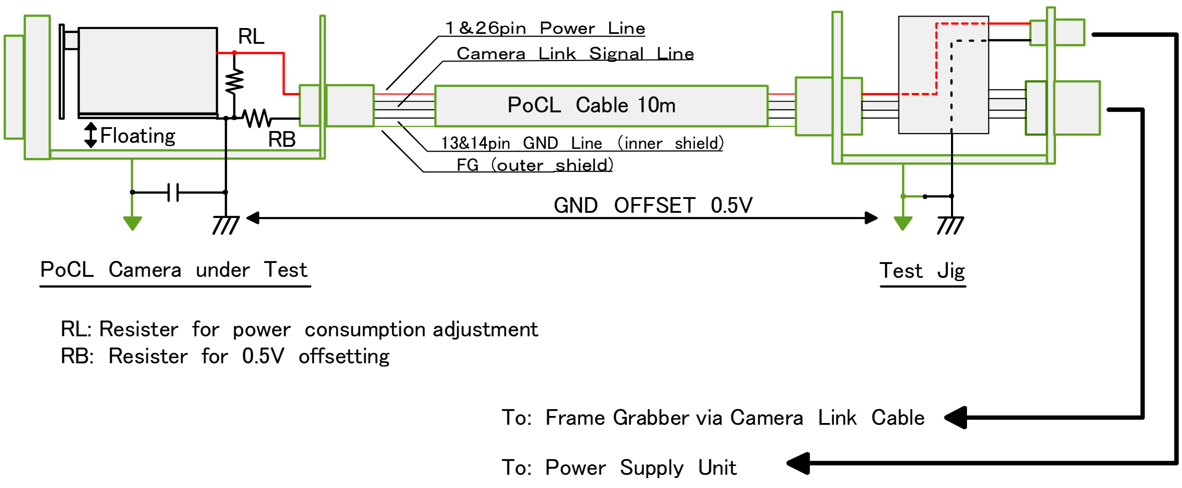
Unstable vertical synchronization

(Vertical shift of output picture: several lines)

(After applied burst stops, system recovers)

After the Burst stops, the system recovers.

Incidentally same phenomenon occurs on Camera Link camera.



PoCL Technical Report 2
Cross talk Measurement

Jan.24, 2006

SUMITOMO 3M LIMITED Takayuki Nagumo

Objective:

To measure cross talk level from the power line to the signal line. The result is to be utilized to specify the requirement of PoCL cable cross-talk level and the frequency characteristics of power line noise elimination LPF.

Measurement items:

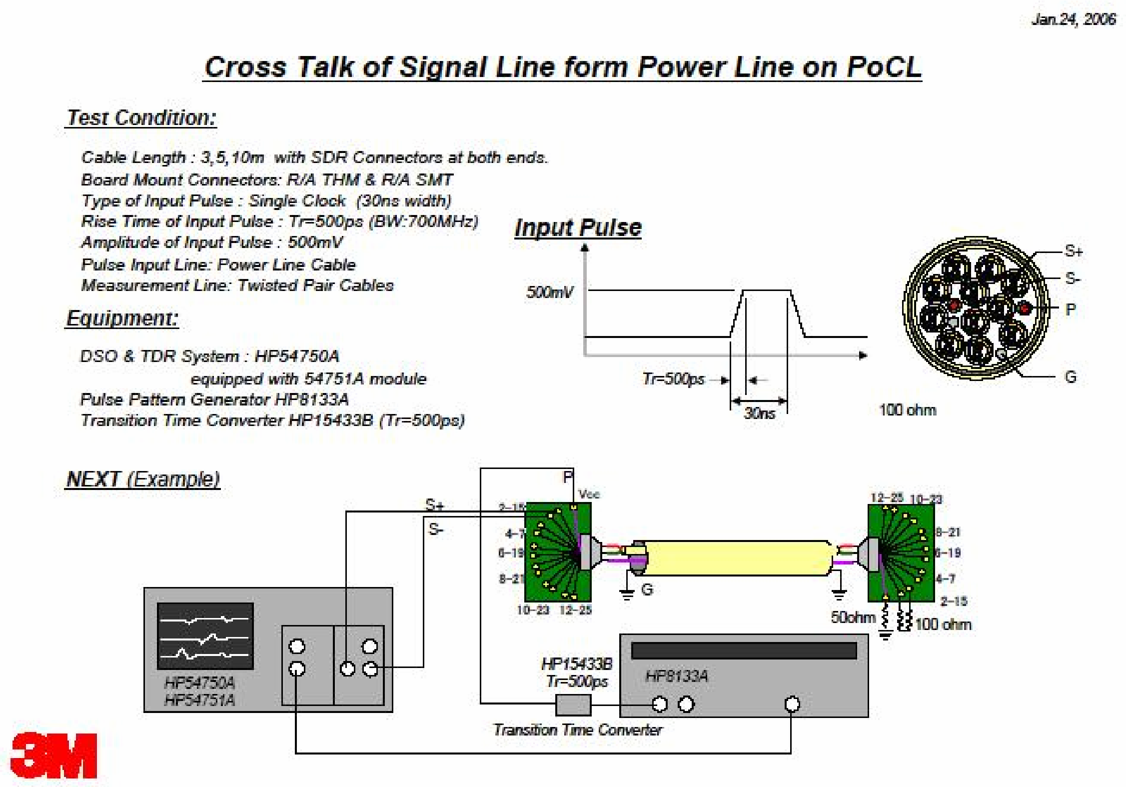
The differential cross talk level of each twisted pair PIN terminal.

The measurement point is Near end and Far end. Each cross talk levels are defined as NEXT and FEXT.

Measurement Result

Max. cross-talk level	:11%(NEXT2pin–15pin;3m,5m,10m)
Frequency characteristic	: The 350 MHz ingredient is dominant.
	(See. Test result Step response wave form)

Measurement System



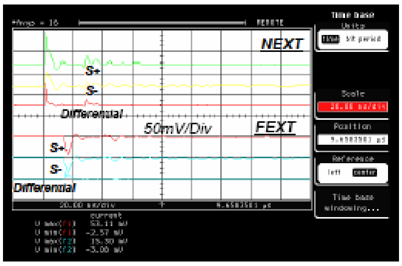
Jan.24, 2006

Cross Talk of Signal Line form Power Line on PoCL

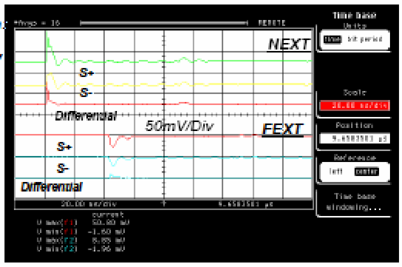
Surface Mount Technology Connector Results

@ Tr=500ps (BW:700MHz) / 500mV

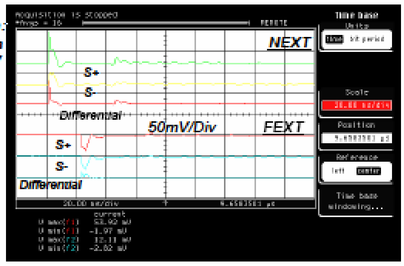
Cable Length: 3m
NEXT =53.11mV (10.6%)
FEXT=15.30mV (3.1%)



Cable Length: 5m
NEXT =50.80mV (10.8%)
FEXT=8.85mV (2.4%)

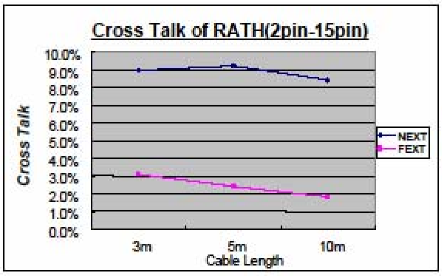


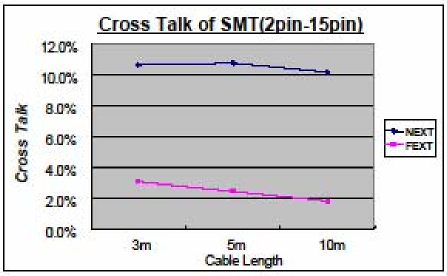
Cable Length: 10m
NEXT =53.92mV (10.2%)
FEXT=12.11mV (1.8%)

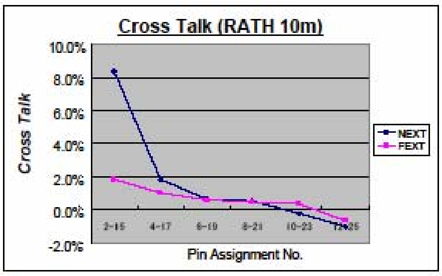


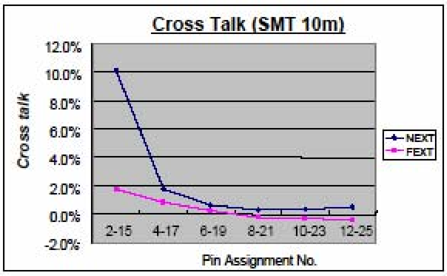
Jan.24, 2006

Cross Talk of Signal Line form Power Line on PoCL









PoCL Technical Report 3 EMI Measurement

Jan.24, 2006

TOSHIBA TELI CORPORATION Koichi Yamakawa
Hitachi Kokusai Electric Inc Katsumasa Ueno
CIS Corporation Ikuo Baba, Hisao Kawamura

Objective:

To evaluate EMI characteristic of PoCL cable with 2 drain wires.

Measurement method:

To compare EMI characteristics of PoCL cable system and Camera Link cable system with 4 drain wires. In this measurement, for both camera systems, same model cameras are used except power transmission method.

Measurement result:

Regarding EMI characteristics there is no obvious difference between PoCL cable with 2 drain wires and Camera Link system with 4 drain wires.

Toshiba TELI. Hitachi Kokusai & CIS, these 3 companies measured respectively by using their own cameras, and all results are same as above.

Following data are the example of these measurements done by Toshiba-Teli

---

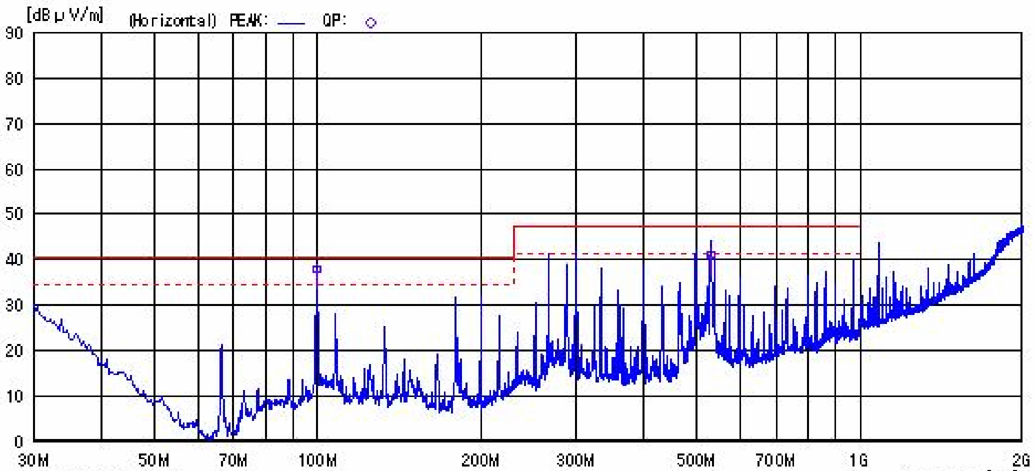
Camera Link

TOSHIBA TELI
Date : 2005/10/07 17:14:26

Model Name	: CCD COLOR CAMERA	Reference No.	: 1
Model No.	: CS6940CL	Power Supply	: CA170 (AC100VIN/DC12VOUT)
Serial No.	: 0000003	Temp/Humi	: 25℃64%
Test Condition	: Nomal	Operator	: A.OSAKA

Memo : POWER DC IN CONNECTOR, CL CABLE 10M, CAMERA CABLE 2M, PC ON, DISPLAY OFF
Data Comment : PoCL評価 電源供給CA170

LIMIT : CISPR Pub.22 Class B (3m)
MARGIN : 6 dB



<< QP DATA >>

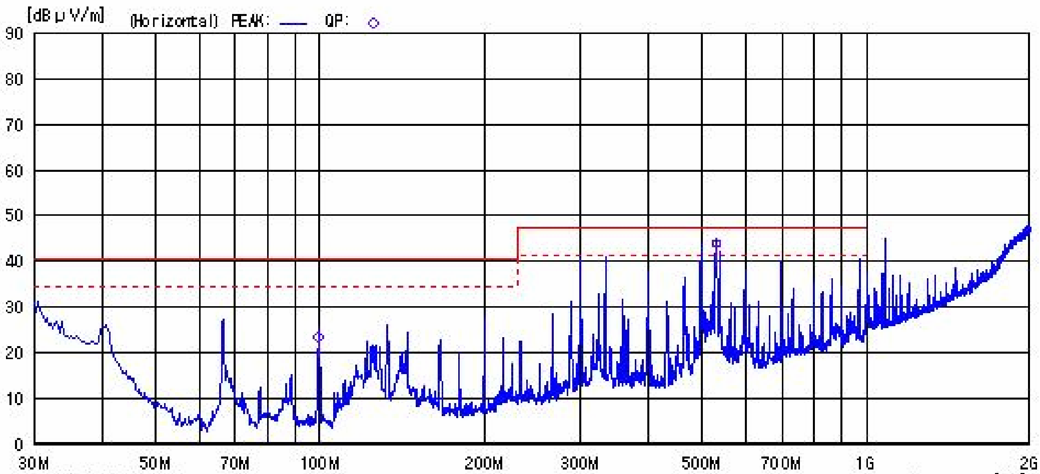
PoCL

TOSHIBA TELI
Date : 2005/10/07 18:57:06

Model Name	: CCD COLOR CAMERA	Reference No.	: 1
Model No.	: CS6940CL	Power Supply	: CA170 (AC100VIN/DC12VOUT)
Serial No.	: 0000003	Temp/Humi	: 25℃64%
Test Condition	: Nomal	Operator	: A.OSAKA

Memo : POWER PoCL, CL CABLE 10M, PC ON, DISPLAY OFF
Data Comment : PoCL評価 電源供給PoCL

LIMIT : CISPR Pub.22 Class B (3m)
MARGIN : 6 dB



<< QP DATA >>

PoCL Technical Report 4
Study of Power Noise Elimination LPF

Mar.15, 2006
CIS Eiji Tamura
CIS Fumio Nagumo

Objective

To study the feasibility of practical power noise elimination LPF

Conclusion

The feasibility is confirmed by an example of LPF (Fig.2, Fig. 3-2, Table 2) which satisfies the required frequency characteristics (-20dB@10KHz) (Fig.4, 5 & 6).

It is certified that the required measurement of LPF Frequency characteristic (“OUT” @Fig. 1-3, “OUT3” @Fig.1-2) represent the noise elimination performance of the LPF in the PoCL system (“OUT1 & OUT2). see Fig.7

A: LPF Measurement method Block Diagram

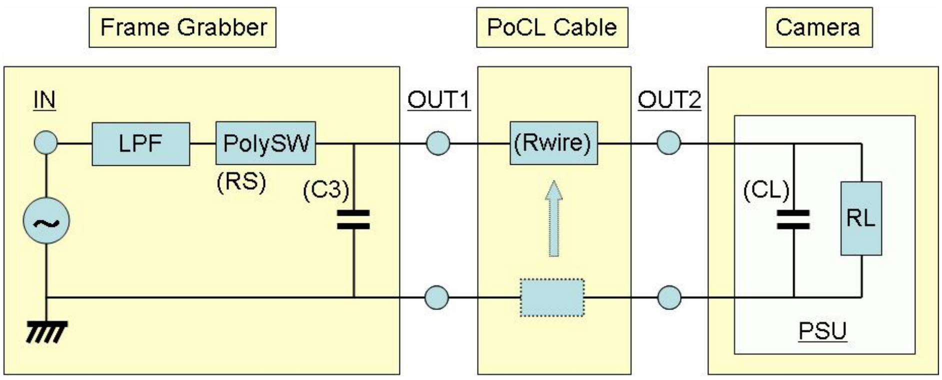


Fig. 1-1 LPF measurement Method 1 (RL =25 Ohm =10V/400mA)

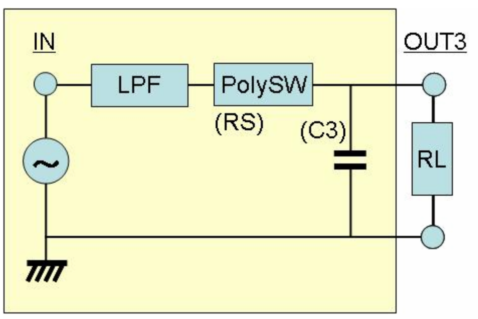


Fig.1-2 LPF measurement Method 2

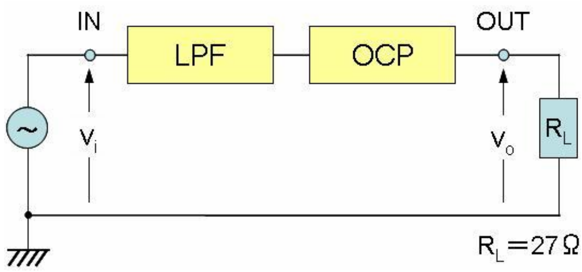


Fig.1-3 Required Measurement Method of the LPF Frequency characteristic (Proposal Appendix-E Fig.2)

B: Example of Noise Elimination LPF

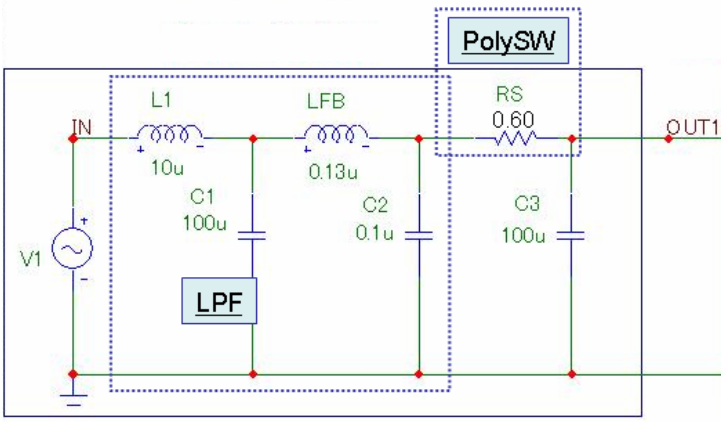


Fig.2 Example of Noise Elimination LPF

PS: (Polyswitch)
miniSMDC050F-2 (Ih=500mA)
LFB: (Ferrite Bead)

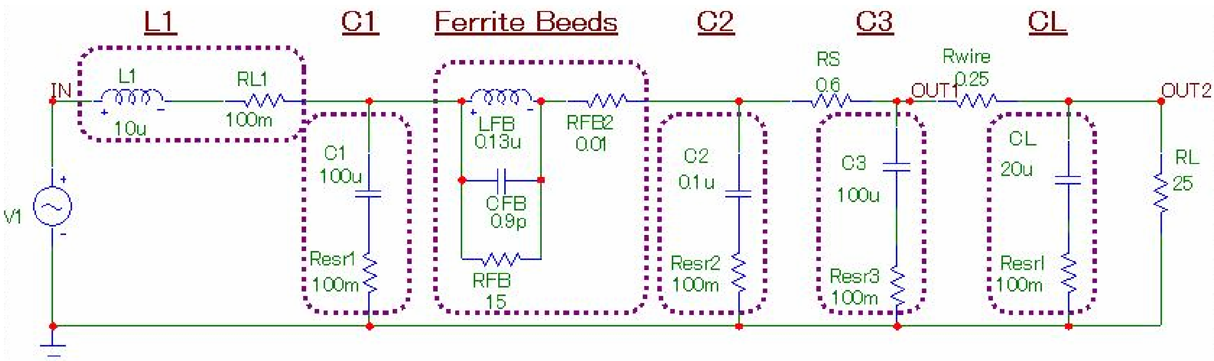


Fig.3-1 Example of Noise Elimination LPF with Parasitic Parameter in the PoCL System (with PoCL Cable)

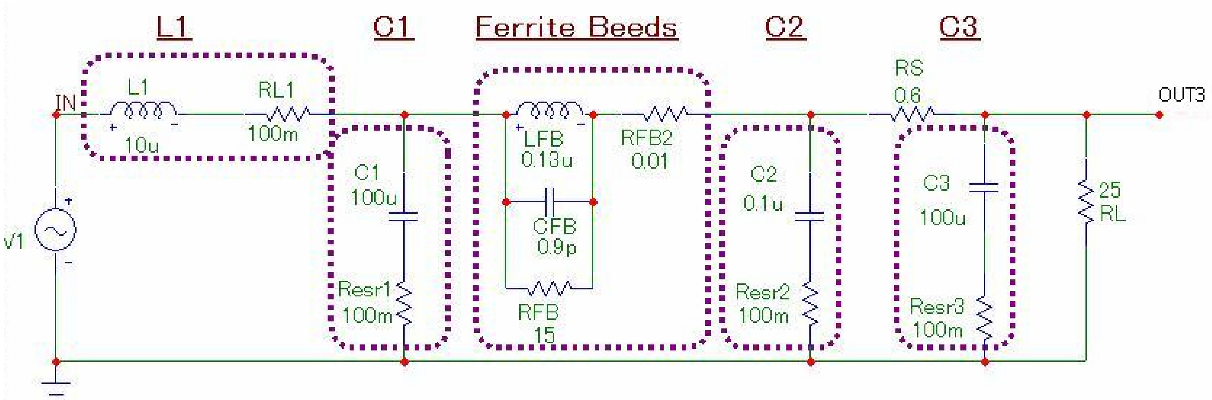


Fig.3-2 Example of Noise Elimination LPF with Parasitic Parameter (without PoCL Cable)

C: Simulation Result and Design Guide Noise Elimination LPF

Table 1: List of LPF Simulation

Fig.4 LPF Freq. Characteristics VS Resistance of PolySW
Table 2 Design Guide of LPF parameter

PolySW		Cable	Camera	Simulation Result			
Ih(mA)	RS (Ohm)	Rwire (Ohm)	CL (uF)		Fig.	OUT1	OUT2
500	0.60	0.25	20	Good	5	D	d
			0		5	E	e
		No Cable	0		6	F	
					7	D,E & F (Comparison)	

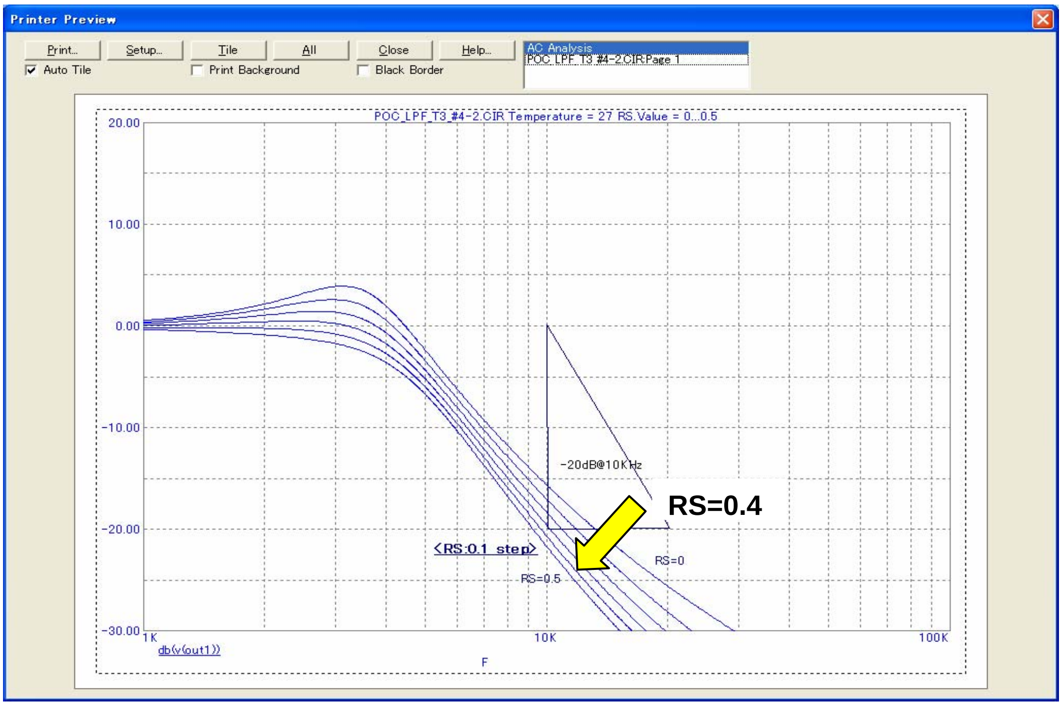


Fig.4 LPF Dumping Characteristics VS Resistance of PolySW

Table 2 Design Guide of LPF parameter

RS*: Additional Dumping Resistance to RS(min,) to suppress resonance

RS=Minimum	**RS=Minimum**
RS = RS(min.) + RS* >0.35 Ohm	RS(min.)
C3=100uF	C3=300uF
PolySW 500mA Type	**PolySW 500mA Type**
RS(min.)=0.15 Ohm / RS* =0.20 Ohm	RS(min.)=0.15 Ohm
C3=100uF	C3=200uF
PolySW 750mA Type	**PolySW 750mA Type**
RS(min.)=0.09 Ohm / RS* =0.27 Ohm	RS(min.)=0.09 Ohm
C3=100uF	C3=300uF

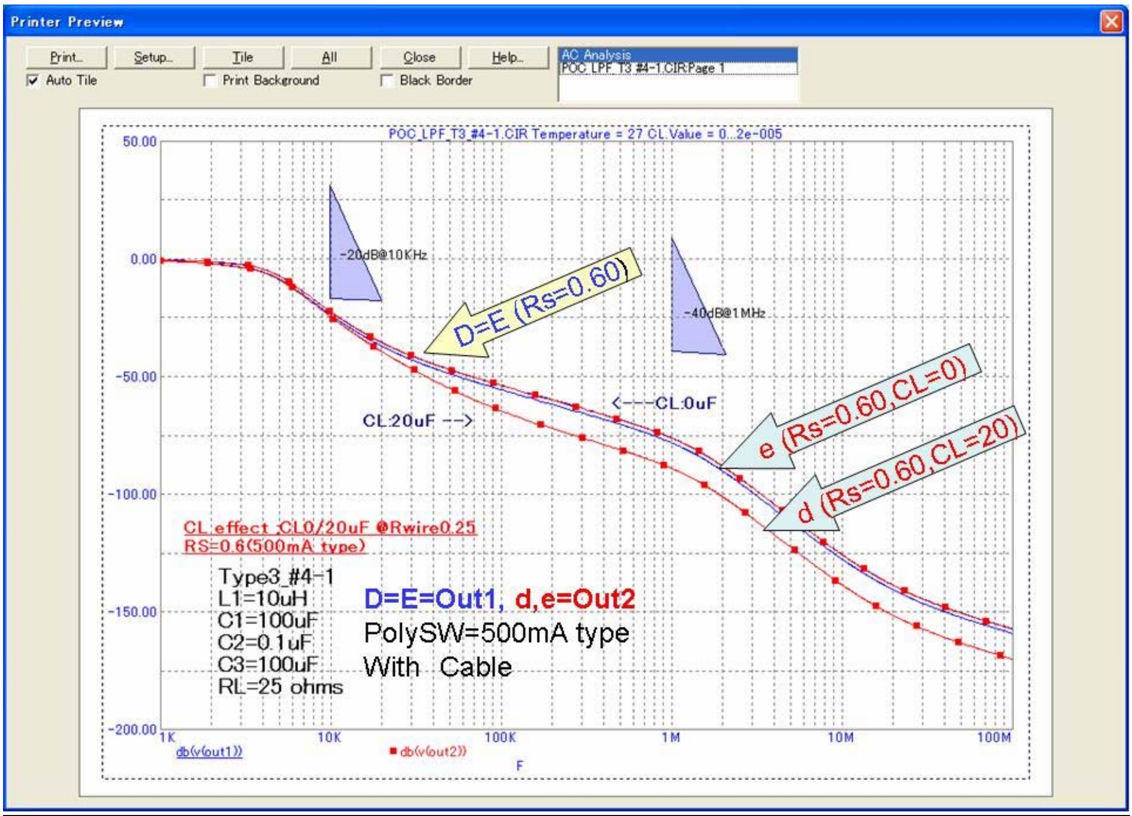


Fig.5 The LPF Frequency Characteristics (Fig.1-1); PolySW=500mA type (RS=0.60 Ohm)

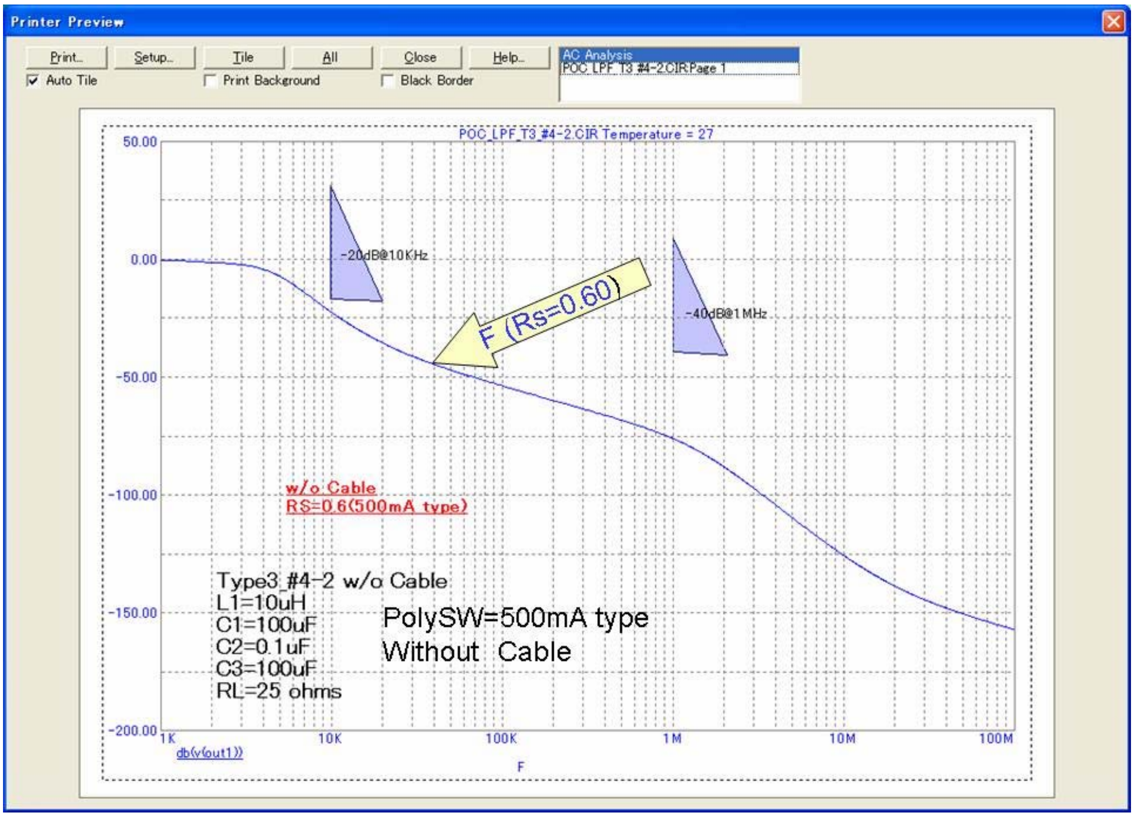


Fig.6 The LPF Frequency Characteristics (Fig.1-2) ; PolySW=500mA type (RS=0.60 Ohm)

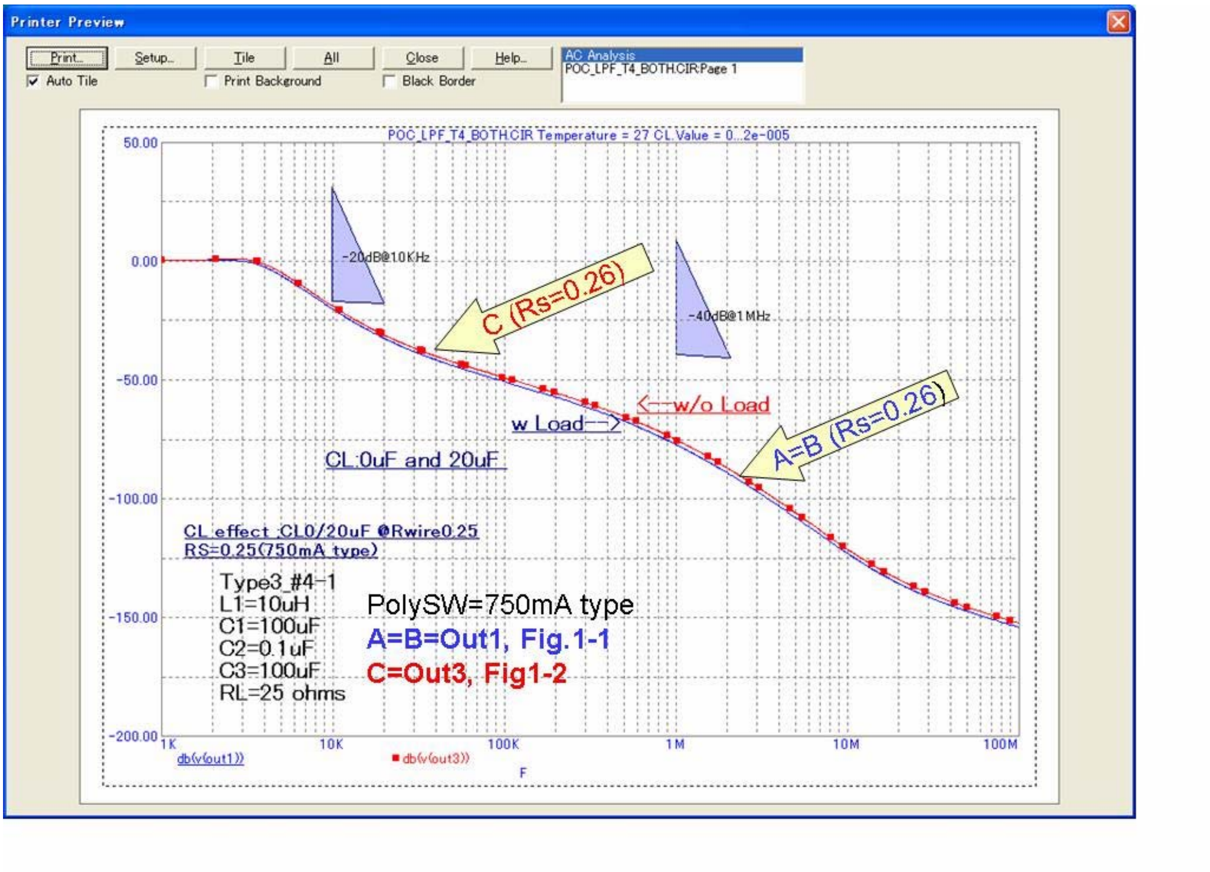


Fig.7 Difference between Test point Out1 in Fig.1-1 and Out3 in Fig.1-2

PoCL Technical Report 5-1

Study of Poly Switch Method for Over Current Protection

Apr.10,2006

MicroTechnica Masanori Meguro

Objective

To study the feasibility of Over current protection using PolySwitch. measuring its inrush characteristics

Measurement item

Inrush characteristics (Rush current, Transient Power)

Conclusion

Over current protection using PolySwitch is possible.

No PC problem happened

Transient Power ≤ 200mJ (PolySwitch Ih=1,000A)

Measurement System

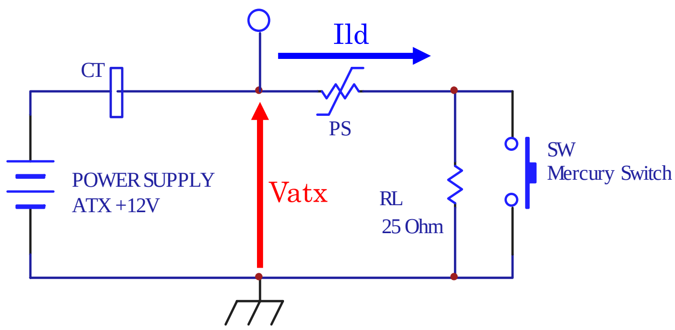


Fig.1 PolySW testing circuit

SW: Mercury Switch

RL: Load Resistance (25 Ohm＝10V/400mA)

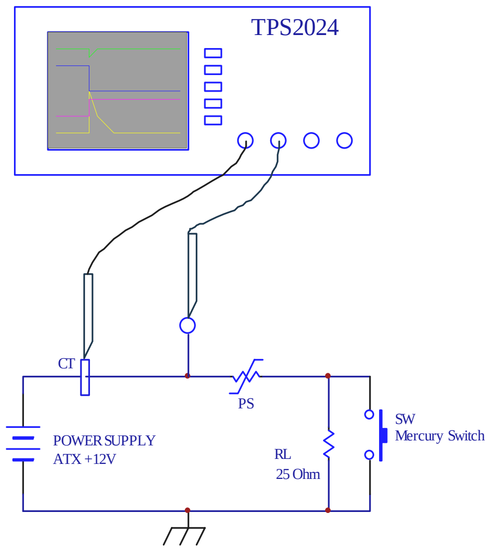


Fig.2 Measurement System

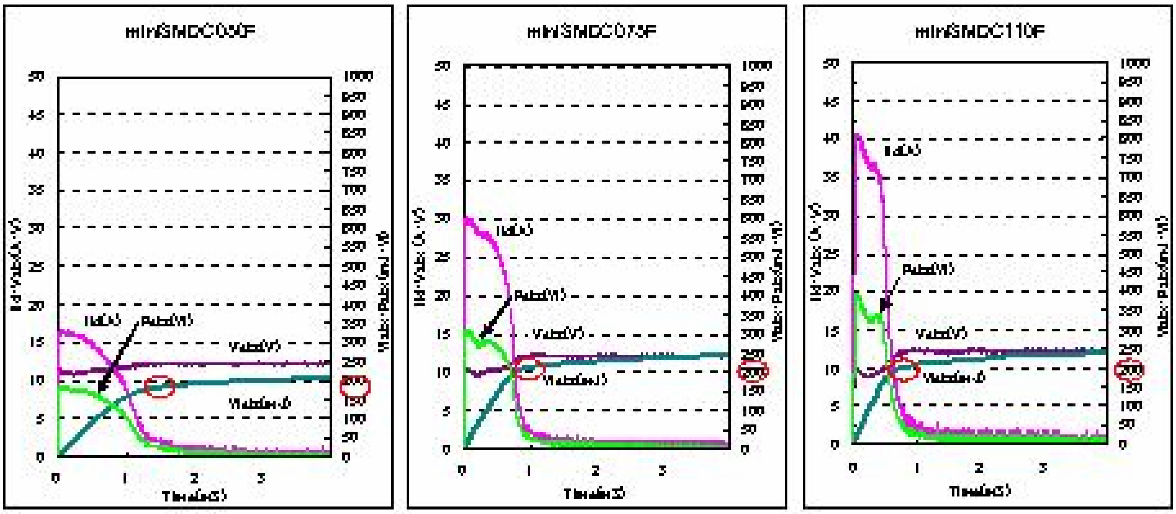
PSU: ATX+12V

Oscilloscope: Tektronix TPS-2024

Measurement Result

PolySW	Resistance (Ohm)	Ih (mA)	Tripping Time(msec)	Peak Current(A)	Transient Power(mJ)	ATX PSU PC
miniSMDC050F-2	0.60(typ.) 0.15~1.00		1.2	17	180	No Problem
miniSMDC075F	0.26(typ.) 0.09~0.29	750	0.9	30	200	No Problem
miniSMDC100D	0.12(typ.) 0.06~0.18	1,000	0.8	40	200	No Problem

Table1 Measurement result



Measurement 1:
miniSMDC050F
(Ih=500mA)
Surge Power=180mJ

Measurement 2:
miniSMDC075F
(Ih=750mA)
Surge Power=200mJ

Measurement 3:
MiniSMDC110F
(Ih=1100mA)
Surge Power=200mJ

Fig. 3 Measurement result

PoCL Technical Report 5-2
Example of Over-Current Protection with Poly Switch Method

MicroTechnica Masanori Meguro

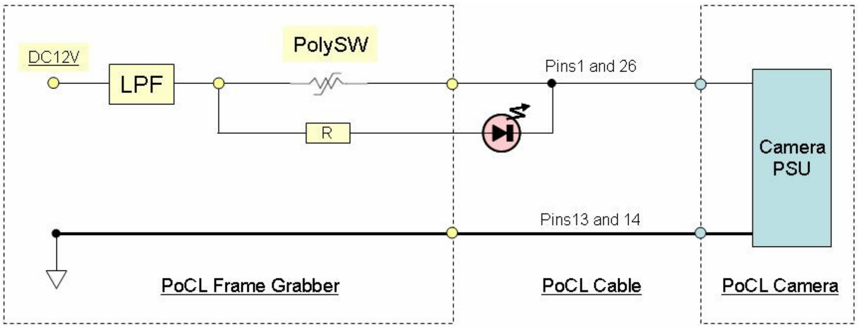


Fig.1 Example of Over-Current Protection Circuit with Polyswitch and LED Alarm

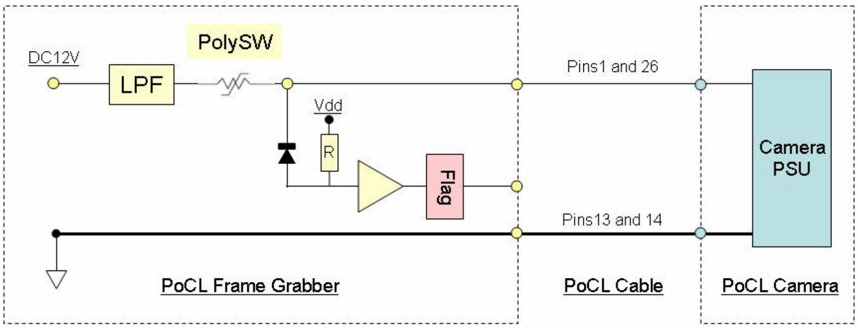


Fig.2 Example of Over-Current Protection Circuit with Polyswitch and Flag Alarm

PoCL Technical Report -6 *SafePower*

Introduction

This document describes the operation of the ***SafePower*** proposal for automatically detecting the presence of a *Power over Camera Link* (PoCL) cable and camera to allow safe switching of the 12V camera power.

Market Requirement

It is important that the addition of PoCL to the Camera Link® standard does not result in compatibility or reliability problems that could result in Camera Link being perceived as a troublesome standard in the marketplace.

Given that the proposed connector pinout re-uses an existing ground connection to supply power, there is clearly the risk of shorting out the computer's power supply if a frame grabber tries to supply power to an existing (non-PoCL) camera.

The use of a Polyswitch® fuse, as previously proposed for PoCL, will protect the computer's power supply, the cable, and the camera from damage or fire risk. However, it may not trip in time to prevent the computer's power supply from shutting down, which would obviously terminate any running programs!

Tests by Active Silicon on a selection of five different types of computer have shown that a 0.5A Polyswitch tripped in time for all five; a 1.1A Polyswitch (as previously proposed for PoCL) resulted in one of the five computers shutting down, and a 1.5A Polyswitch resulted in three of the five computers shutting down. Note that the computer which shut down with a 1.1A Polyswitch was an embedded one, which did not use a standard ATX style power supply. This could be typical of embedded systems often used with Camera Link.

If the tests at 1.1A are typical, then 20% of customers could unintentionally shut down their computers by plugging in the wrong camera or selecting the wrong setup file. This is likely to result in lots of support emails and phone calls – not good at all.

Therefore there is the need for a simple, low cost, detection circuit – ***SafePower***.

Concept

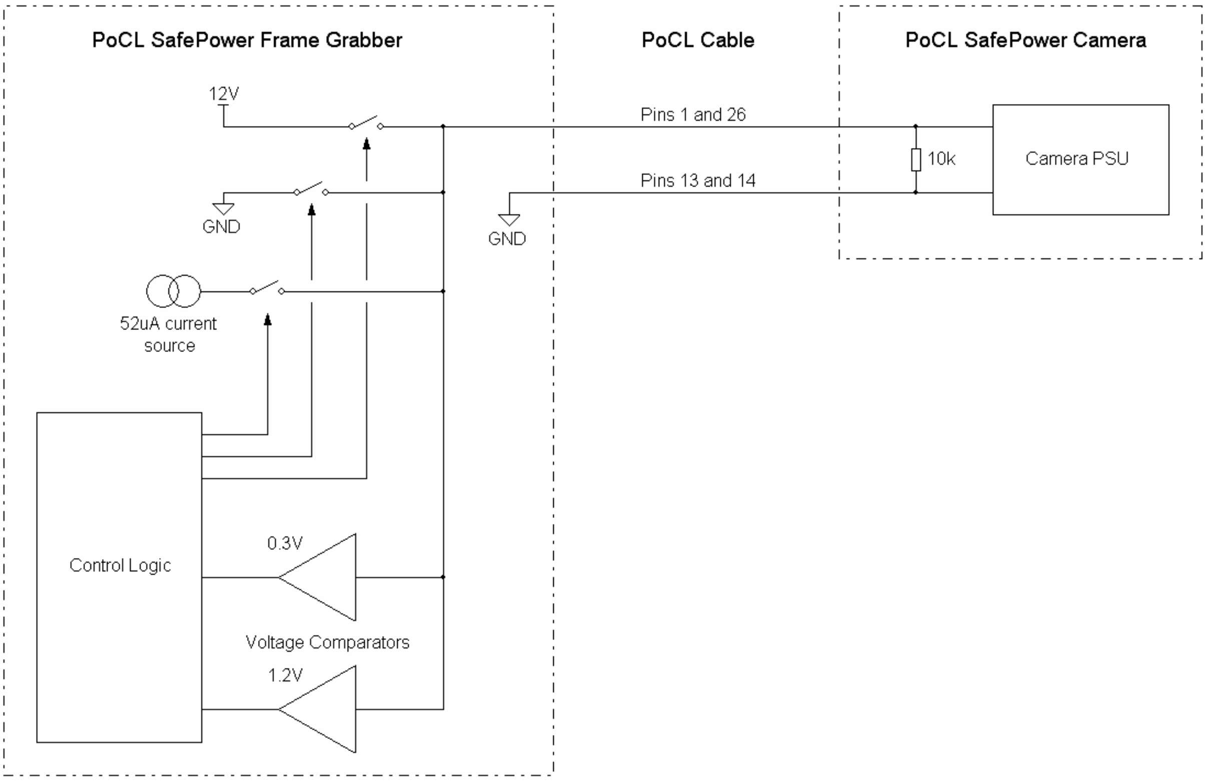
SafePower is a protocol designed to allow the frame grabber to automatically detect the type of connected camera, and only turn on the power to a PoCL camera.

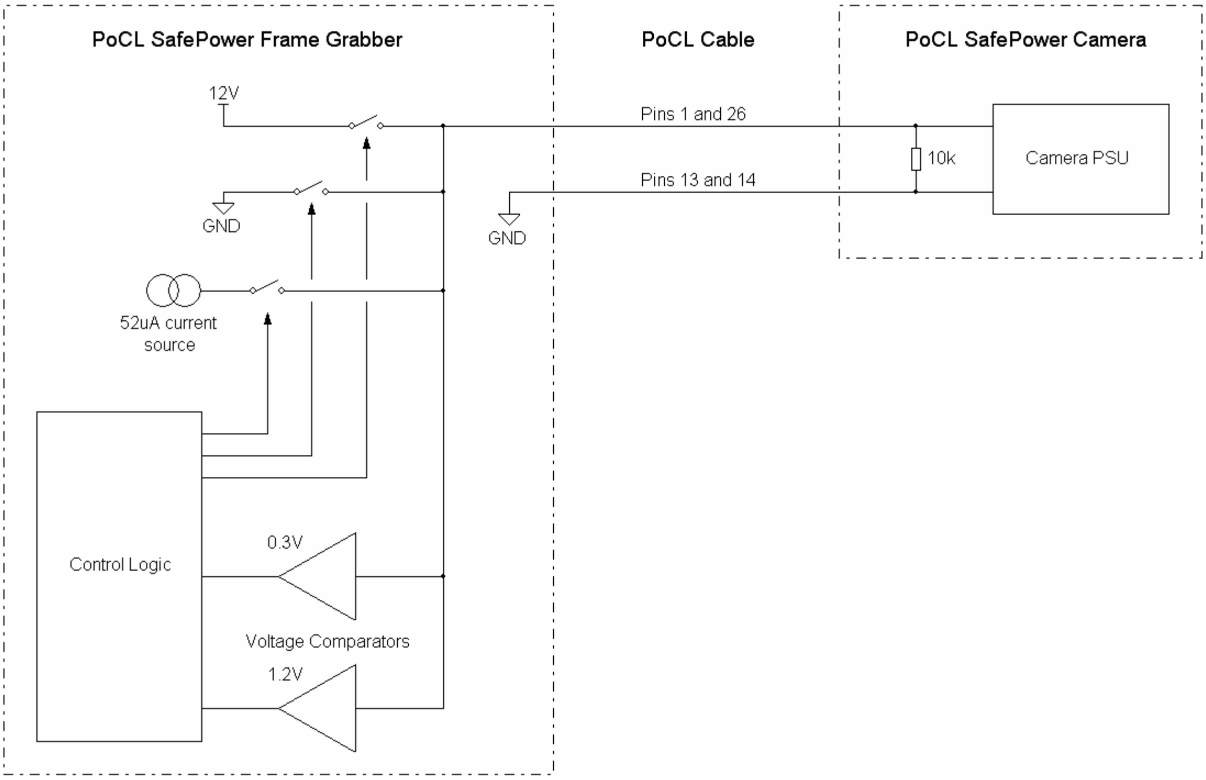
Note that ***SafePower*** is not an alternative to an inrush protection device, which is still needed for safety requirements.

Basic Principles of Operation for *SafePower*

- The camera has a defined 4k7 input impedance between connector pins 1 & 26 and ground.
- Before driving either power or ground to the camera, the frame grabber drives out a defined 0.1mA sense current via connector pins 1 & 26, and after a defined time delay, senses the resulting voltage.
- If a PoCL camera and cable is connected, the sense current will result in a voltage across the defined input impedance of the camera. The frame grabber senses this voltage, and therefore supplies 12V to connector pins 1 & 26, powering the PoCL camera.
- If a non-PoCL camera or cable is connected, the sense current will drive into a short circuit, and zero volts will be sensed. The frame grabber then grounds connector pins 1 & 26, giving compatibility with the existing Camera Link standard.

These functional blocks are shown in the following circuit:





Detailed Requirements – Camera

Parameter	Value	Comments
Input Impedance	Nominal 4k7 Ohms Precise definition: A 0.11mA sense current should result in a voltage drop of 0.52V ± 5%.	The 0.52V voltage is low enough that the camera's power supply does not start to draw significant current, which could otherwise result in a much lower apparent impedance. The precise definition given allows any current consumed by the power supply to be taken into account in choosing the sense resistor.
Input Capacitance	Maximum 57uF	This value is sufficient for a high frequency switching supply, and needs to be defined so that the frame grabber knows how long to wait before testing the sensed voltage. The value of 57uF allows a 47uF 20% component to be used.

Note that the 4k7 Ohm sense resistor will result in an additional 31mW power dissipation in the camera at 12V, which should not be significant.

Detailed Requirements – Frame Grabber

Parameter	Value	Comments
Sense Current	0.11mA ± 10%	This will result in 0.52V across the defined 4k7 Ohm camera impedance.
Sense Time Delay	Minimum 0.5s	Half a second is sufficient for two 4k7 / 57uF RC time constants, which gives a stable sense voltage to measure. It is not too significant in an overall system startup time.
Sense Voltage Threshold 1	Nominally 0.3V	Values above 0.3V indicate a PoCL system; below 0.3V indicate a non-PoCL system. Note that the total tolerance of 15% gives a sense voltage range for a PoCL camera of 0.44V to 0.6V.
Sense Voltage Threshold 2	Nominally 1.2V	A second optional comparator at this voltage allows the system to sense the higher voltage that would result if no cable or camera was connected.

It is recommended that the Frame Grabber drives an LED or similar indicator near the Camera Link connector to show when the Frame Grabber is driving out 12V to the camera.

Implementation Comments

Camera

All that is needed in the camera is a 4k7 Ohm resistor.
The camera's power supply needs to be checked to ensure that it meets the maximum capacitance and minimal current consumption requirements at 0.52V. The PoCL cameras already produced by the WG-Japan companies working on PoCL already meet these requirements.

Frame Grabber

The frame grabber needs the following:

- Ability to switch pins 1 & 26 to ground, 12V, or disconnected from either.
- Ability to generate a 0.11mA sense current.
- Ability to detect a 0.3V sense voltage.

Switching pins 1 and 26 to ground or 12V is needed on any frame grabber that wants to support PoCL as well as non-PoCL, so is arguably not directly a ***SafePower*** requirement. However it is easy to implement with a simple and cheap circuit using two FET switches.
Generating the sense current could be as simple as a tri-state buffer in a FPGA, driving out

through a resistor, via a diode to protect the FPGA from 12V when camera power is on. The 10% tolerance on the sense current allows for a simple circuit to be used.

Detecting the 0.3V sense voltage probably needs a dedicated comparator or op-amp, but these only cost cents. (Note Active Silicon's original proposal used a 1V sense voltage, which would allow a simple transistor circuit as a detector, but at 1V the cameras' power supplies started drawing significant current, preventing correct sensing). A simple RC filter would minimise the risk of noise affecting the sense voltage – and software filtering could also be implemented to make the sensing robust even in very noisy environments.

Note: The 12V power supply would need the same filter circuit as already proposed by WG-Japan, and would still need an inrush protection device such as a Polyswitch for safety approval requirements. The comparator can also be used to detect a low voltage after power has been enabled to the camera, indicating that the inrush protection device has tripped. This allows the frame grabber to turn off power, and prevents leaving the protection device in a high temperature tripped state for extended periods.

Restrictions

There is one scenario that this proposal does not address:

- A frame grabber is started up with a PoCL cable and camera attached.
- ***SafePower*** therefore turns on 12V power to the PoCL camera.
- The user then unplugs the PoCL camera, and plugs in a non-PoCL camera, without telling the software that any change has been made.

This will result in a 12V to 0V short, just as with the simple fuse proposal, with the same risk of shutting down the computer's power supply.

This problem could be solved by detecting the camera being disconnected, and then shutting down 12V power as a result. This could be done with a clock detection circuit (very simple in an FPGA). Can any Camera Link Committee members see any problems with making this a requirement of ***SafePower*** / PoCL? The requirement could be stated as:

"The loss of camera clock for at least 1/2 second is deemed to indicate that the camera has been disconnected, and the frame grabber must disconnect power, and go back into sense mode, only restoring power if a PoCL camera is reconnected."

Recommendation

SafePower is a simple and low cost method to allow a reliable implementation of PoCL. Active Silicon therefore strongly recommends that it is made a requirement of the Camera Link PoCL specification.

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