Project Kifer
(05 Dec 2003)

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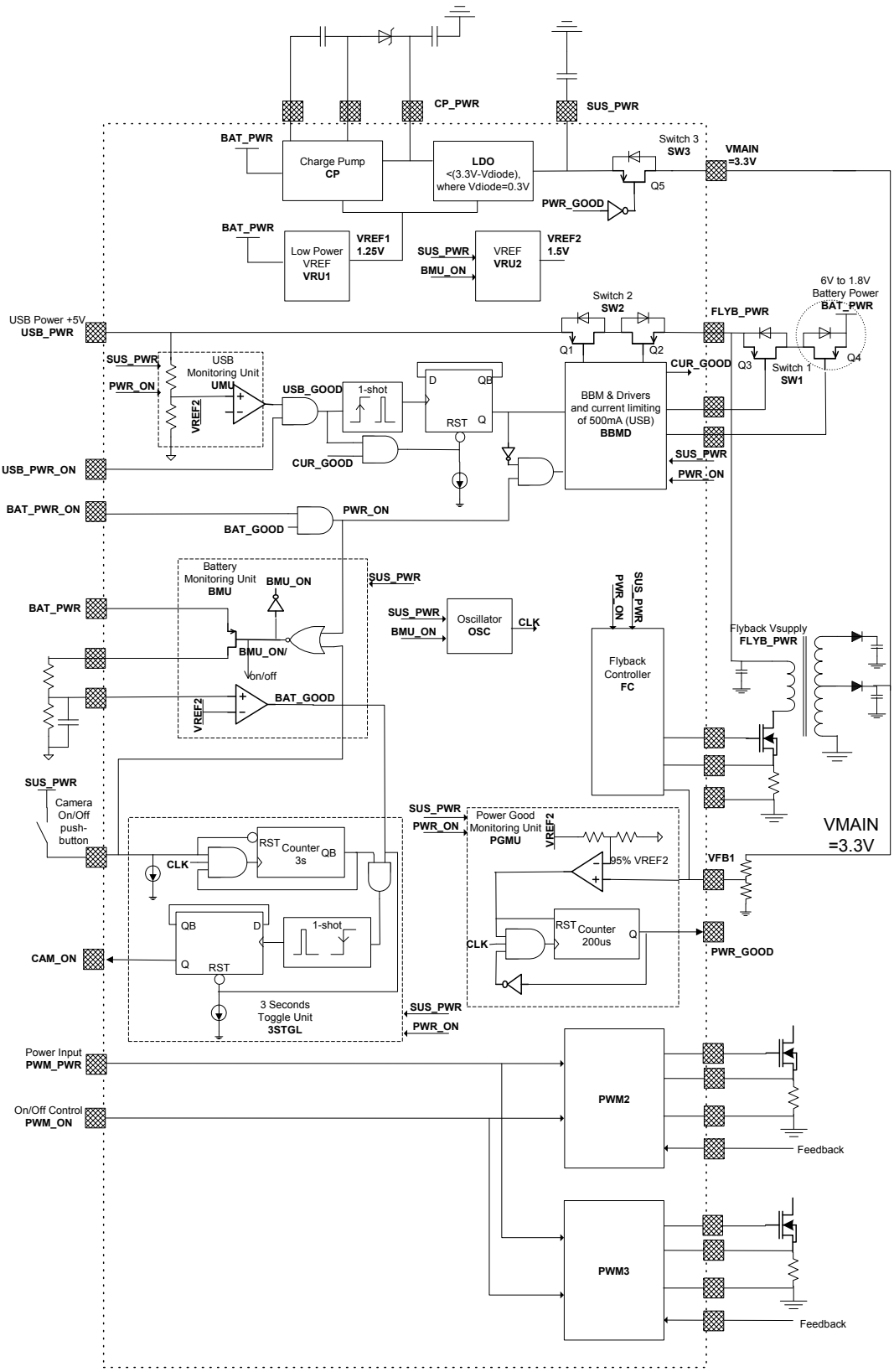
Block Diagram

The block diagram of Project Kifer is as shown:

The functions of various signals are described.

Signal Name	Direction	Description
Power and Communication with Host		
USB_PWR	From Host	+5v USB power from Host.
BAT_PWR	From Battery	Battery voltage from 1.8V to 6V.
SUS_PWR	To DSP	To power DSP and the system (Kifer) during suspend-mode.
USB_PWR_ON	From DSP	Use USB power.
BAT_PWR_ON	From DSP	Use Battery power.
PWR_GOOD	To DSP	+3.3V is good.
CAM_ON	To DSP or To Kifer	The camera on/off button is pressed for at least 3 seconds. It can be connected to BAT_PWR_ON for camera to self-start.
Internal		
BMU_ON	Internal	In suspend-mode, when user press the camera on/off button, BMU_ON is asserted to enable BMU, OSC and REF. This ensures 3STGL is functioning to verify the user action and BMU to measure battery voltage.
BAT_GOOD	Internal	If asserted, battery voltage is good.
USB_GOOD	Internal	If asserted, USB voltage is good.
PWR_GOOD	Internal	If asserted, +3.3V is good.
PWR_ON	Internal	If BAT_GOOD=1 and BAT_PWR_ON=1, it is asserted. It is used to shut down non-essential block during the suspend-mode and turn on the entire chip during the Battery or USB powered mode.

* When Kifer or DSP is in suspend-mode and being powered by LDO working at possible low output voltage of 1.8V, the logic high (asserted) of the signals can vary from 1.8V to 3V. Logic low is 0V.


CP_PWR
SUS_PWR
BAT_PWR
Charge Pump
CP
LDO
<(3.3V-Vdiode),
where Vdiode=0.3V
Switch 3
SW3
VMAIN
=3.3V
Q5
PWR_GOOD
BAT_PWR
Low Power
VREF
VRU1
VREF1
1.25V
SUS_PWR
BMU_ON
VREF
VRU2
VREF2
1.5V
6V to 1.8V
Battery Power
BAT_PWR
Switch 2
SW2
FLYB_PWR
USB Power +5V
USB_PWR
Q1
Q2
Q3
Q4
Switch 1
SW1
SUS_PWR
PWR_ON
USB
Monitoring Unit
UMU
VREF2
USB_GOOD
1-shot
D
QB
RST
Q
CUR_GOOD
BBM & Drivers
and current limiting
of 500mA (USB)
BBMD
USB_PWR_ON
BAT_PWR_ON
PWR_ON
BAT_GOOD
Battery
Monitoring Unit
BMU
BMU_ON
BMU_ON/
on/off
BAT_GOOD
Oscillator
OSC
CLK
Flyback
Controller
FC
Flyback Vsupply
FLYB_PWR
VMAIN
=3.3V
Camera
On/Off
push-
button
RST
Counter
3s
QB
CLK
Power Good
Monitoring Unit
PGMU
95% VREF2
VFB1
RST
Counter
200us
PWR_GOOD
CAM_ON
1-shot
3 Seconds
Toggle Unit
3STGL
Power Input
PWM_PWR
On/Off Control
PWM_ON
PWM2
PWM3
Feedback
Feedback

The functions of various blocks are explained.

System

The desired switching frequency is 1MHz, but 600KHz is acceptable. **Zoran prefers to have a fixed-frequency switching system. However, a variable-frequency scheme will be adopted first.**

Transformer

The transformer will have several taps to deliver several voltages. Only one voltage (VMAIN) is used as feedback signal by the flyback controller.

Switch 1, 2, 3 and BBM & Drivers (BBMD)

The total power supplied by external sources, namely battery and USB power, is normally around 1.1W for a small camera and between 2.1W to 2.6W for a high-end camera.

1.1W is used for the design of Kifer. SW1 is off-chip taken into consideration that battery voltage can go as low as 1.8V and resulted in higher current, assuming that the power is constant. SW2 is on-chip since USB voltage is roughly equal to 5V.

SW1 will be based on FDW2508P during the simulation.

Q4 can be taken out if battery voltage is always less than USB voltage.

It is likely that battery voltage of camera is either from 1.8 to 3V or 3.6 to 6V depending on the intended battery used.

Hence for SW1, expected average current flow is **220mA** (1.1/5). Likewise, **1.44A** (1.1/1.8) for switch 2.

A sensing mechanism must be in place to monitor the current through SW1. The current should be limited to 500mA according the USB specification. Current sensing circuit might not be accurate, but the absolute maximum of 500mA should not be exceeded. If above the limited, SW1 must be turned off.

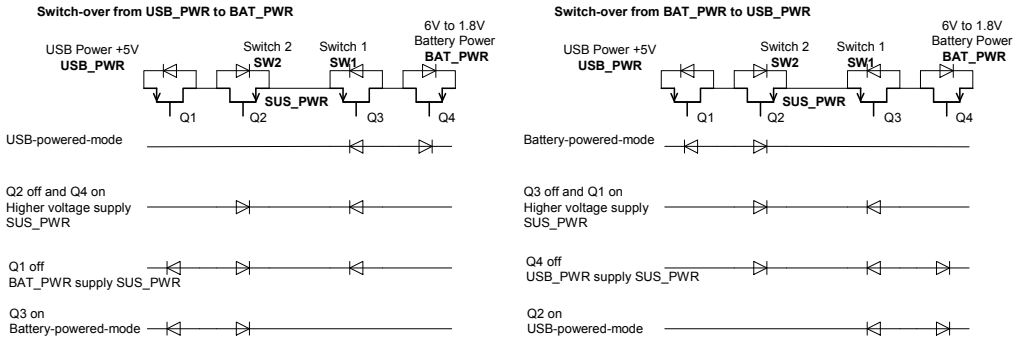
One of the outputs, driving the SW1 can be used to let DSP knows that Kifer switched on battery despite the permission to use USB power. To unlatch this, DSP should toggle USB_PWR_ON.

Q5 body diode will allow VMAIN to start to supply current to SUS_PWR when VMAIN is greater than SUS_PWR. When PWR_GOOD=1, Q5 is on and VMAIN taken over SUS_PWR and LDO is off. **The turning on of Q5 should be soft and turning off can be sharp (advice from Vlad).**

BBMD controls the switching of voltage from battery to USB or vice-versa.

When USB_PWR_ON is asserted, SW2 must be opened and SW1 closed. Both switches should not be on at the same time since voltage level of battery and USB Power are different. At the instance when both switches are off, the system should remain powered. The inrush current drawn from USB during switch on of SW2 should be avoided. <<BBM and timing control needed to ensure this>>.

The sequences of switch-over of supply are as shown.



Battery Monitoring Unit (BMU)

The battery voltage is monitored for protection of battery. If the voltage level is less than a set voltage, BAT_GOOD=0. The switch is used to prevent loading by the two resistors. The unit is only off in the suspend-mode.

Assuming battery (AA alkaline) internal ESR=0.2Ω. With 2 cells battery, the total internal ESR=0.4Ω. When battery internal voltage is 2.04V and sourcing 0.6A, the battery external voltage is 1.8V. Hence the minimum low threshold voltage level of BMU is 1.8V. Below 1.8V, the circuit design is difficult.

Let us assume high threshold voltage level of BMU is 2.0V. When the camera just turn on, when flyback converter is not yet operating, the battery external voltage could be closed to 2.04V and hence BAT_GOOD=1. After PWR_GOOD=1, the battery external voltage could drop to <1.8V and hence the camera will shut-down. To avoid such 'chattering' situation, the high threshold voltage level should be set higher.

USB Monitoring Unit (UMU)

The USB voltage is monitored for the presence of USB. If the voltage level is less than a set voltage, USB_GOOD=0. The unit is only on in the USB-powered-mode.

Power Good Monitoring Unit (PGMU)

VMAIN is monitored. When it is above a threshold, counter is activated. After 200us, PWR_GOOD is asserted. If VMAIN drop below the threshold, PWR_GOOD is immediately de-asserted.

Linear Regulator (LDO)

When BAT_PWR>3V, LDO output voltage should be fixed at 3V. When BAT_PWR<3V, LDO output voltage should be closed to BAT_PWR with certain dropout voltage <<of 50 to 80mV>>. The LDO must work as long as battery supply voltage is present in the camera. During suspend-mode, 20uA is expected from LDO to supply to DSP. LDO has to be able to supply enough current to start-up each block when entering into battery-powered-mode, since SUS_PWR is supplying Kifer during suspend-mode. The quiescent current of the LDO must be **<1uA** <<CP and VRU1 will draw more than this>> in any condition.

3 Seconds Toggle Unit (3STGL)

During the suspend-mode, when the camera on/off button is pressed, VRU, OSC and BMU is turned on. If counter reaches 3 seconds of counting and the BAT_GOOD=1, CAM_ON is asserted. DSP will have to assert BAT_PWR_ON before the user releases the button, in order to have PWR_ON=1.

Alternately, CAM_ON can be connected to BAT_PWR_ON for camera to self-start without DSP instruction.

During battery-powered-mode or USB-powered-mode, when the button is pressed for 3 seconds, CAM_ON will be de-asserted for DSP to initiate a camera shut-down action. It is assumed that BAT_GOOD=0 will result in PWR_ON=0 and hence PWR_GOOD=0. DSP will know that some conditions have resulted in PWR_GOOD=0 and battery voltage too low is one of them.

Any pressing of button of less than 3 seconds is interpreted as accidental action of the user and logic level of CAM_ON will not be changed.

Low Power Voltage Reference Unit (VRU1)

It generates the voltage reference for CP and LDO. Its accuracy is not important but current consumption must be very low.

High Accuracy Voltage Reference Unit (VRU2)

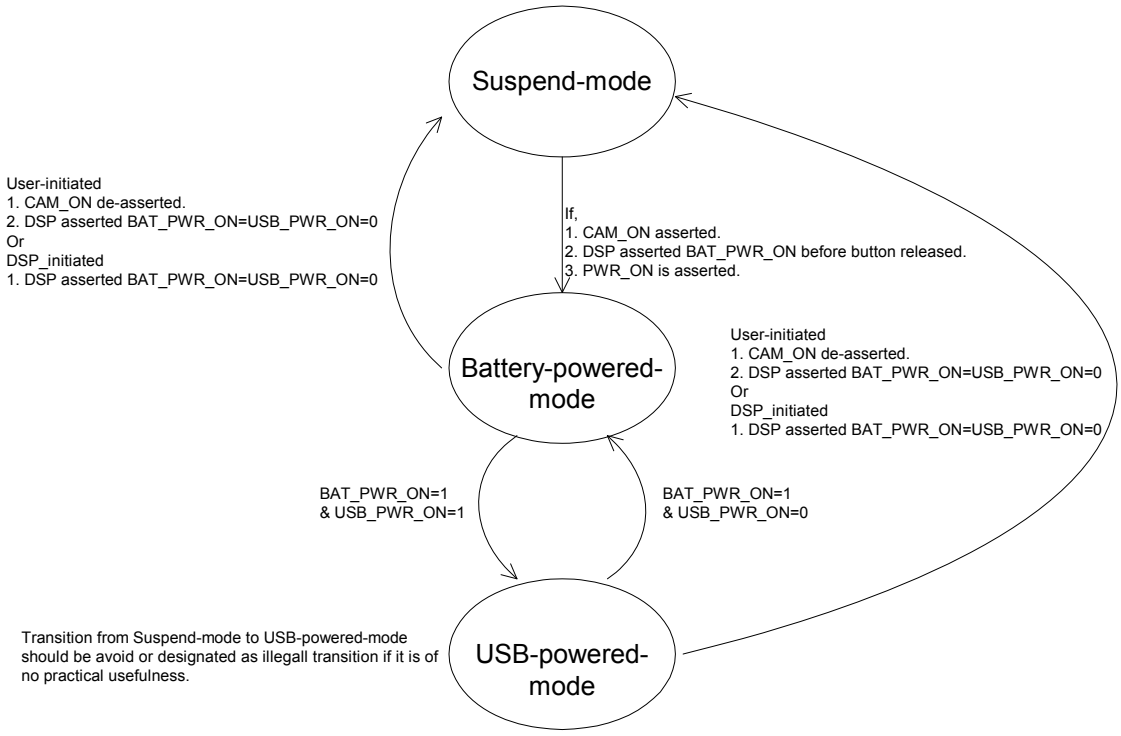
This provides an accurate voltage reference for Kifer.

Oscillator (OSC)

An external Capacitor might be needed to provide the timing unless 3 seconds and 200us do not need to be accurate. <<refer to Kea 512KHz osc>>

Transition Diagram

The transition diagram of Kifer is as shown:



There are three modes of operation for Kifer as shown in the table.

Mode	BAT_PWR_ON	USB_PWR_ON	Remarks
Suspend-mode	0	0	
Battery-powered-mode	1	0	
USB-powered-mode	1	1	
Illegal mode	0	1	Do not use

During suspend-mode, PWR_ON=0, PWR_GOOD=0 and all circuit are shut down except VRU1, CP and LDO. LDO is providing the SUS_PWR for DSP and some logic gates of Kifer.

When the user presses the camera on/off button while in suspend-mode, BMU will wake up to make voltage measurement of battery. OSC and VRU will wake up in order for BMU and 3GTGL to function. Once 3 seconds is reached, CAM_ON is asserted. DSP responds by asserting BAT_PWR_ON=1. If the battery voltage is correct, PWR_ON=1. Note that BAT_PWR_ON must be asserted before user release the camera on/off button. Once PWR_ON=1, BMU, OSC, VRU2 will remain on for the next sequence of actions. SW1 is turned on to connect BAT_PWR to FLYB_PWR. FC and PGMU is turned on. Once VMAIN is correct, PWR_GOOD=1. Then VMAIN is connected to SUS_PWR and LDO is off automatically. Prior to PWR_GOOD=1, the circuits draw power from SUS_PWR.

To transit to USB-powered-mode, USB_PWR_ON is asserted. If USB_GOOD=1, then SW2 will be on and SW1 off. The in-rush current of USB_PWR due to the switch-over period should be avoided. The USB_PWR will be current sensed and limited or protected to 500mA.

While in Battery-powered-mode or USB-powered-mode, and the user presses the camera on/off button for 3 seconds, CAM_ON is de-asserted. DSP then de-asserted BAT_PWR_ON, which resulted in PWR_ON=0. All circuits and switches will be off. LDO is on to take over SUS_PWR.

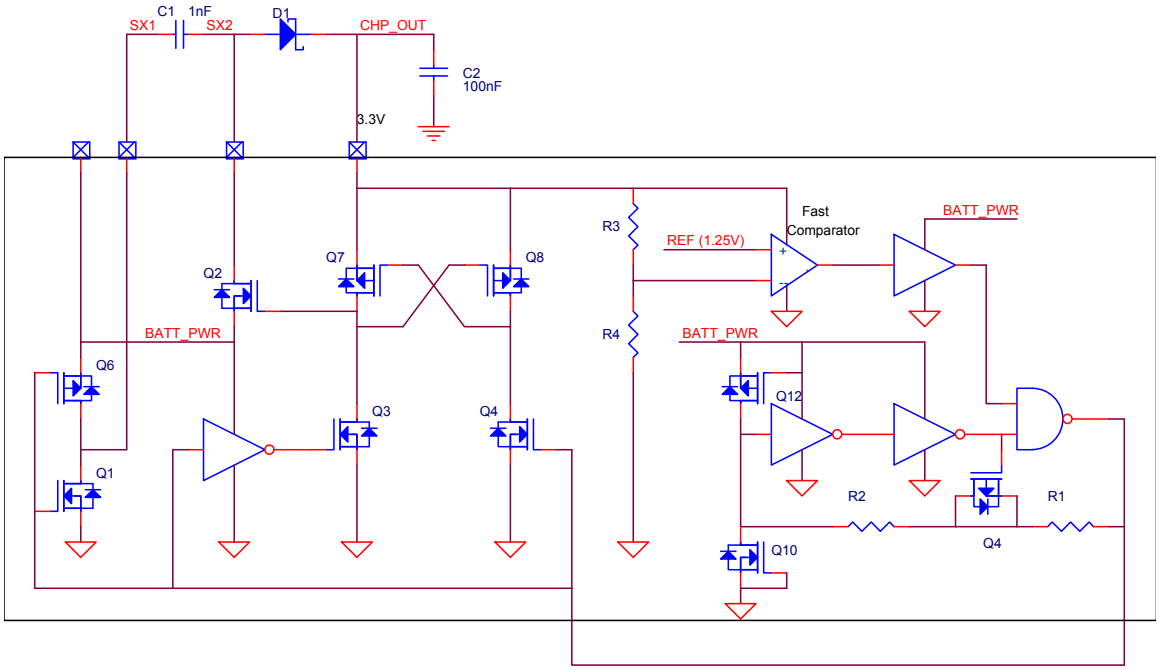
<<Suggest ion: UMU's opamp is on only if PWR_ON=1 and USB_PWR_ON=1.>>

Specification

Recommended Operating Conditions

	MIN	NOM	MAX	UNIT
Operating Junction Temperature Range, Tj	-40		125	°C
Supply Voltage (From Battery)	1.8		6	V
Supply Voltage (From USB)	4.375		5.25	V

PARAMETER	TEST CONDITIONS	MIN	NOM	MAX	UNIT
USB Monitoring Unit, Comparator					
High Voltage Threshold			4.5		V
Low Voltage Threshold			4.375		V
Battery Monitoring Unit, Comparator					
High Voltage Threshold			2.1		V
Low Voltage Threshold			1.8		V
VRU1					
Supply Voltage	From Battery	2		6	V
Reference Voltage	Don't need to be accurate, but low power		1.25		V
CP					
Supply Voltage	From Battery	2		6	V
Output Voltage		3		5	V
LDO					
Supply Voltage	From CP	2.5		5	V
Output Voltage	During start-up	2.5	3.3		V
	During suspend-mode		2		V
Output Current	During start-up	10			mA
	During suspend-mode		20		uA
Supply Voltage of Kifer (except LDO, CP, VRU1)					
Supply Voltage	From SUS_PWR	2.5		5	V
Switch 2, Q1 and Q2					
Ron of Q1	At VGS≈5V		0.5		Ω
Ron of Switch 2	At VGS≈5V		1		Ω
USB Current Protection					
Current Limit		400	450	500	mA


C1 1nF
SX1
SX2
D1
CHP_OUT
C2
100nF
3.3V
R3
REF (1.25V)
Fast
Comparator
BATT_PWR
Q2
Q7
Q8
R4
BATT_PWR
Q6
Q3
Q4
Q12
Q1
R2
R1
Q4
Q10