AIC1605

High Voltage Interface IC

RoHS COMPLIANT

FEATURES

- Wide supply voltage range (5 V to 36V)
- Built-in 5 V/20 mA linear regulator
- Adjustable fixed-frequency buck regulator (8 V to 34 V)
- P-Type and N-Type open drain outputs, 100 mA, over-Current and short-circuit protected
- Two LED current sinks, 2 mA
- Two generic operational amplifiers
- Buck and linear regulators useable in different configurations
- Wide range of target applications

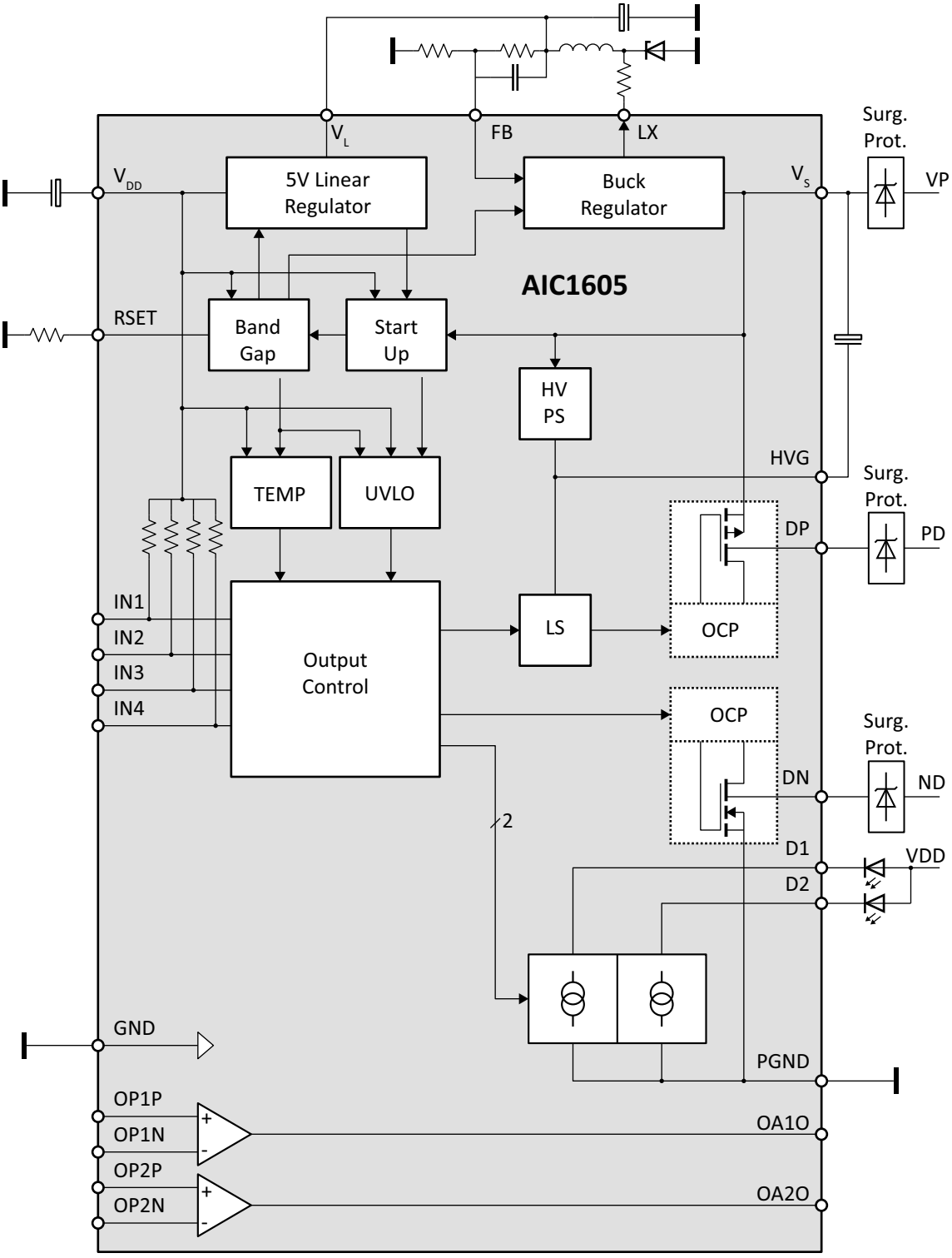
APPLICATIONS

- Inductive Proximity Sensing Companion
- Optical Switch Drive
- Pre-amplifier
- LED Driver
- DC Motor Control
- UART - RS232 Converter
- MCU, I/O or sensor interface

DESCRIPTION

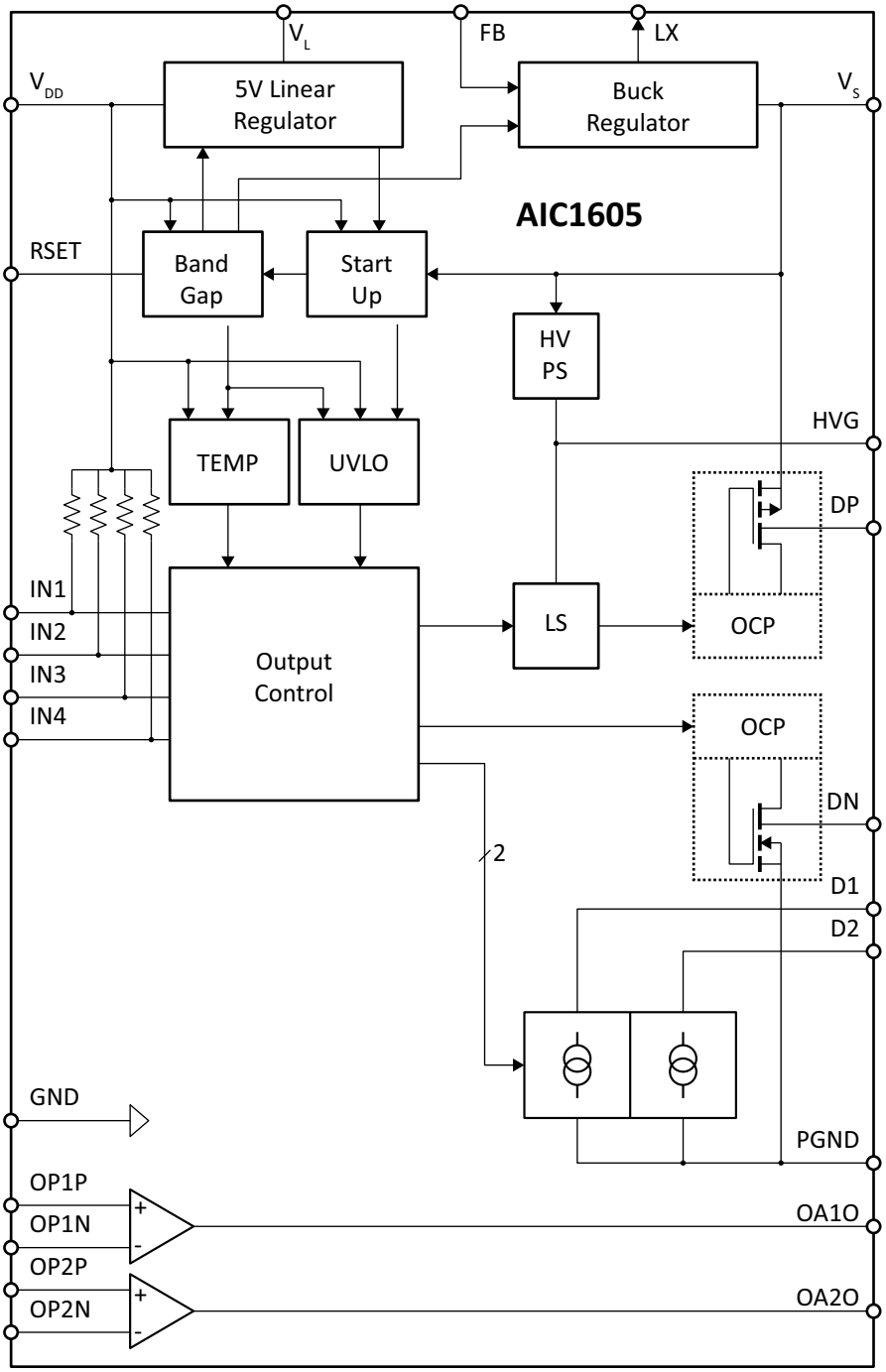
The AIC1605 provides high voltage N-Type and P-Type open drain outputs, a buck and linear regulator as well as two OP-AMPs and two LED drivers. It is highly suitable for building a three-wire sensor interface. It can be used also as a supply or output stage for various other applications.

Figure 1: Simple Application Circuit



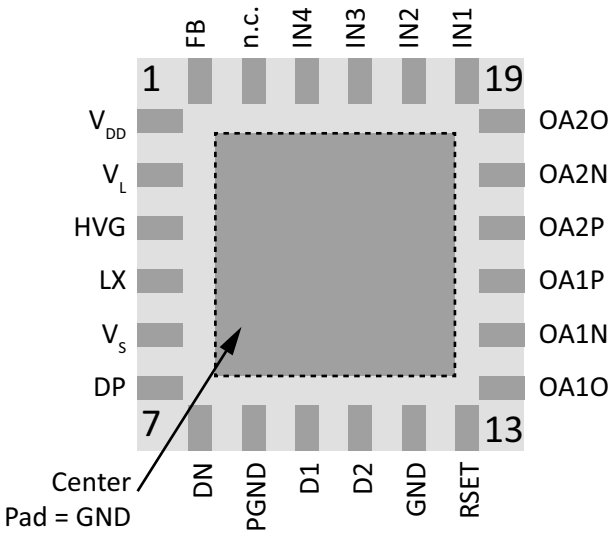
BLOCK DIAGRAM

Figure 2: Block Diagram



PINOUT AND DESCRIPTION TABLE

Figure 3: AIC1605 Pinout (Top View)



Pin Number	Name	Description
1	V_{DD}	Linear regulator output and decoupling output
2	V_L	Linear regulator input voltage
3	HVG	HV Decoupling
4	LX	Buck regulator output
5	V_S	Supply voltage
6	DP	Open drain output of P-Driver
7	DN	Open drain output of N-Driver
8	PGND	Power Ground
9	D1	LED current sink input 1
10	D2	LED current sink input 2
11	GND	Analog GND
12	RSET	Bias Current Set Resistor
13	OA1O	Operational Amplifier 1 output
14	OA1N	Inverting input of Operational Amplifier 1
15	OA1P	Non inverting input of Operational Amplifier 1
16	OA2P	Non inverting input of Operational Amplifier 2
17	OA2N	Inverting input of Operational Amplifier 2
18	OA2O	Operational Amplifier 2 output

19	IN1	Logic Input
20	IN2	Logic Input
21	IN3	Logic Input
22	IN4	Logic Input
23	NC	Not connected
24	FB	Buck regulator feed back input

SPECIFICATIONS

Unless otherwise noted: T_J = 25°C, voltage supply V_S = 36 V.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit
Supply voltage	V_S		37.8	V
Maximum voltage at pins DP, DN, D1, D2, LX, VL, HVG (high voltage pins)	$V_{PIN,HV}$	-0.3	V_S+0.3	V
Maximum analog voltage supply (if applied from external)	V_{DD}		5.5	V
Maximum voltage at all other pins (low voltage pins)	$V_{PIN,LV}$	-0.3	V_{DD}+0.3	V
Drain output current	I_{DN}, I_{DP}		100	mA
Buck regulator output current for external loads	I_{BO}		50	mA
Linear regulator output current for external loads	I_{DD}		25	mA
Storage temperature range (see chapter 14.2)	T_{STG}	-55	150	°C
Junction temperature	T_J	-55	150	°C
ESD Protection Test voltage (HBM, MIL-STD-883D, Method 3015.7 class 2)[1]	V_{ESD}	-2000	2000	V

1. ESD test condition valid for any pin without external protection circuitry

NORMAL OPERATING RANGE

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage, using buck and linear regulator	$V_{S,BS}$	7.5		36	V
Supply voltage, using linear regulator only	$V_{S,SO}$	5.75		36	V
Supply voltage, using buck regulator only	$V_{S,LX}$	6.5		36	V
Analog supply voltage, if applied externally	V_{DD}	4.5		5.5	V
Ambient operating temperature	T_A	-25		85	°C
I/O switching frequency	f_{SW}	400		600	kHz

DC CHARACTERISTICS

General

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply current w/o external loads, with buck regulator in steady state	I_{VS1}				1	mA
Supply current w/o external loads, buck regulator deactivated	I_{VS2}			260		µA
Bias current reference voltage	V_{RSET}			1.25		V

Buck Regulator

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage range (adjustable by external resistor divider)	V_{VL}	$V_S \geq 10$ V $I_{LOAD,\ BUCK}$ = 40 mA	4.75	8	V_S - 2	V
Saturation voltage drop	$V_{DROP,B}$	$I_{LOAD,\ BUCK}$ = 40 mA		2		V
Reference voltage	V_{FB}			2.5		V
Overvoltage lockout	$V_{FB,OV}$			2.75		V
Operating current	I_{BUCK}	$V_{FB} < V_{FB\_OV}$		TBD		mA
Buck switch off input voltage	V_{FB_BOFF}			3.5	V_{DD}	V

5V Linear Regulator

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output voltage	V_{DD}	6 V ≤ V_{VL} ≤ 16 V $I_{LOAD,\ VDD}$ = 20 mA	4.75	5	5.25	V
Output voltage saturated	$V_{DD,SAT}$	5.5 V ≤ V_{VL} ≤ 6.5 V $I_{LOAD,\ VDD}$ = 20 mA	V_{VL} - 1			V
Saturation voltage drop	$V_{DROP,DD}$	$I_{LOAD,\ VDD}$ = 20 mA		1		V

Open Drain Drivers (FETs)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
P-channel R_{DS}(on) voltage drop	$V_{DROP,DP}$	$I_{LOAD,P}$ = -100 mA			1	V
N-channel R_{DS}(on) voltage drop	$V_{DROP,DN}$	$I_{LOAD,N}$ = 100 mA			1	V

LED Current Sinks

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
LED Driver constant current sink	I_{LED}	V_{DX} = 36V	1.8	2	2.2	mA

Operational Amplifiers

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
OP-AMP input voltage range	$V_{IN,OA}$		0.5		V_{DD}-0.5	V
Input Offset voltage	$V_{IN,OFFSET}$	I_{OUT} = 0 µA		10		mV
		I_{OUT} = ±100 µA		15		mV
OP-AMP input current	$I_{IN,OA}$				200	nA
OP-AMP output voltage range	$V_{OUT,OA}$		0		V_{DD}	V
OP-AMP output current driving capability	$I_{OUT,OA}$	$V_{OUT,C}$ = V_{DD}/2			±1	mA

Logic Inputs

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Logic HIGH input current	$I_{IN,H}$	V_{DD} = 4.5 ~ 5.5 V	-0.1		0.1	uA
Logic LOW input current	$I_{IN,L}$	V_{DD} = 4.5 ~ 5.5 V	-50		-10	uA
Logic LOW input voltage	$V_{IN,L}$		0		0.3* V_{DD}	V
Logic HIGH input voltage	$V_{IN,H}$		0.5* V_{DD}		V_{DD}	V

AC CHARACTERISTICS

Buck Regulator

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output switching frequency	f_{SW}			500		kHz
Duty Cycle	DC				95	%

Operational Amplifiers

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Transit frequency	f_T	Open loop	1	2.8		MHz
Max voltage gain	gvmax	Open loop		105		dB
Voltage gain	gv	Open loop; 10 kHz	40	49.5		dB
Common mode rejection ratio	CMRR	10 kHz		-71		dB
Power supply rejection ratio	PSRR	10 kHz		-51.3		dB
Phase Margin	M_{PH}	open loop (f_T)		72.7		deg

OUTPUT CONTROL - LOGIC TABLE

Inputs				Outputs			
IN1	IN2	IN3	IN4	LS	HS	LD1	LD2
1							ON
0							OFF
	1				ON		
	0				OFF		
		1		ON			
		0		OFF			
			1			ON	
			0			OFF	

APPLICATION

SUPPLY CONCEPTS

The AIC1605 can be used with different supply strategies and ranges. It contains a buck regulator and a linear regulator. The minimum voltage drops of the regulators are

- Buck regulator: V_{DROPB} = 2 V (to be adjusted by external resistor divider)
- Linear regulator: V_{DROPL} = 1 V (in case of saturation, $V_{VL} \leq 6$ V).

Either none or one or both regulators may be used (considering the limitations of operational voltages and power losses).

Figure 4: Supply Concept Using Buck Regulator and Linear Regulator

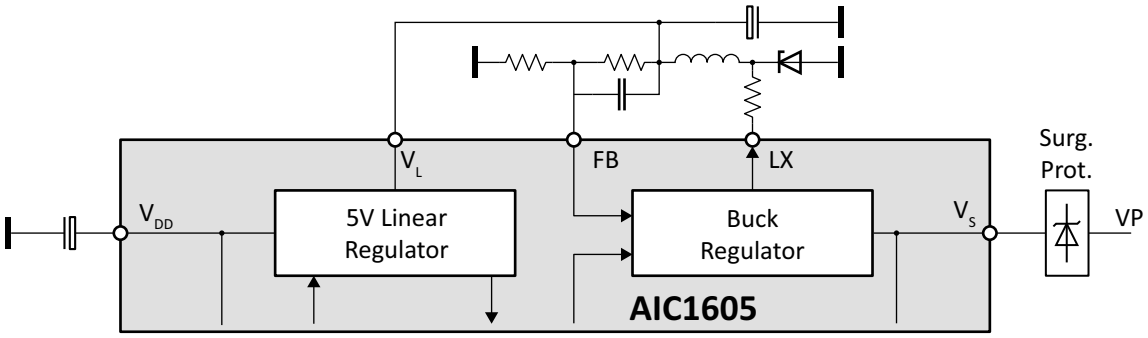


Figure 5: Supply Concept Using Buck Regulator Only

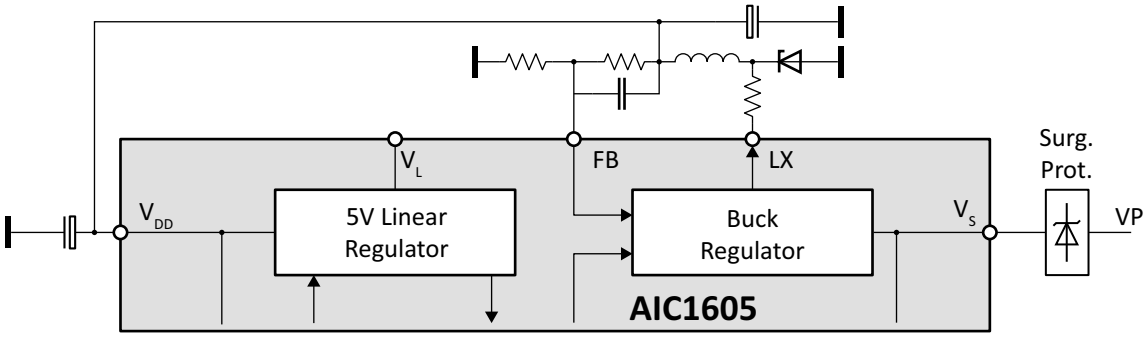


Figure 6: Supply Concept Using Linear Regulator Only

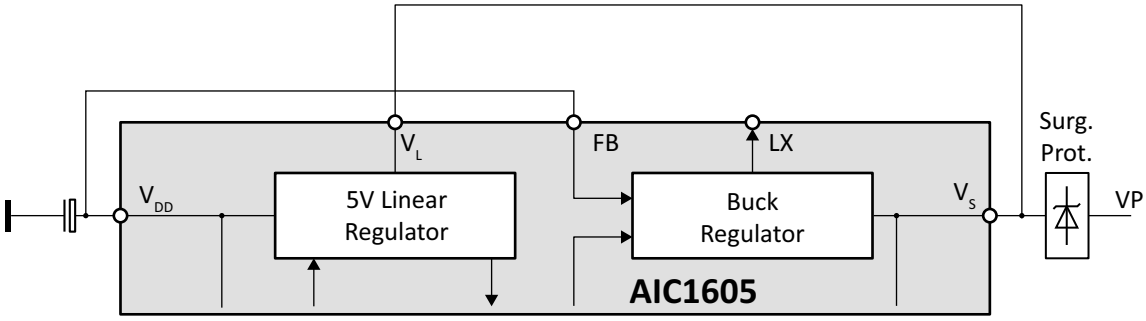
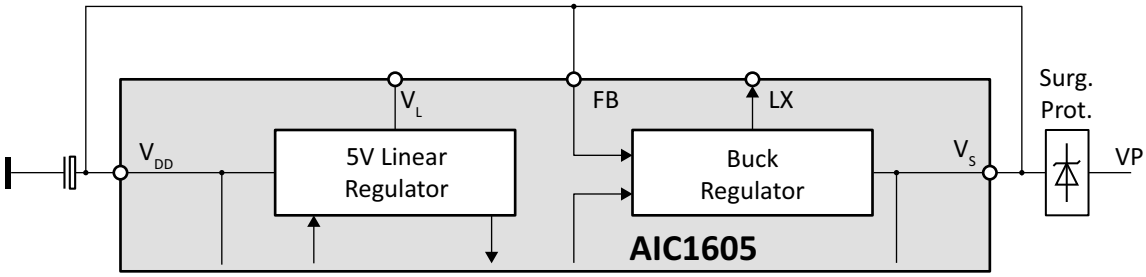


Figure 7: Supply Concept with External 5V Supply



The buck regulator is able to drive about 40 mA external load in total. If it has to supply the linear regulator, the maximum external load driving capability will be reduced by the load of the linear regulator (max. 20 mA).

- The buck regulator's external coil should be larger than 220 µH
- The external resistor R_{ST} should be between 39 and 62 Ohm.

SURGE PROTECTION

Pins which are subject to surges need to be adequately protected by external protection devices and appropriate PCB layout. The functionality of the IC might get interrupted during surges.

FUNCTIONAL BLOCKS

Over Current Protection (OCP) Block

The OCP block limits the currents of the N- and P-Type open drain outputs.

Level Shifter (LS)

The internal level shifter translates the switching signals from the low voltage domain to the high voltage domain. It is dedicated to drive the gate of the P-Type open drain output.

High Voltage Power Supply (HVPS)

The HVPS supplies the level shifter block with the high voltage needed to drive the gate of the P-Type open drain output. It supplies also the N-Type open drain output's protection circuit and the buck regulator's driver stage.

Under Voltage Lock Out (UVLO)

The UVLO block detects under-voltage events of VDD supply voltage and disables the outputs in case of such events. This prevents the IC from malfunctions caused by under-voltage events.

Over-Temperature Protection Block (Temp)

The Temp block prevents the IC from thermal overload. In case of thermal overload the outputs will be switched off.

Buck Regulator

This block allows to build a step-down DC-DC converter (buck converter). Depending on the load it supports continuous current mode, discontinuous current mode and cycle skipping mode. The buck regulator is over-current and short circuit protected.

5 V Linear Regulator

The 5 V Linear Regulator is a shunt regulator which can be used to generate about 5 V from voltages up to 36 V. It is over-current and short circuit protected.

Open Drain Drivers

The AIC1605 provides open drain N-Type and P-type outputs with ? 100 mA output current driving capability each. The outputs are over-current and over-temperature protected.

LED Current-Drivers

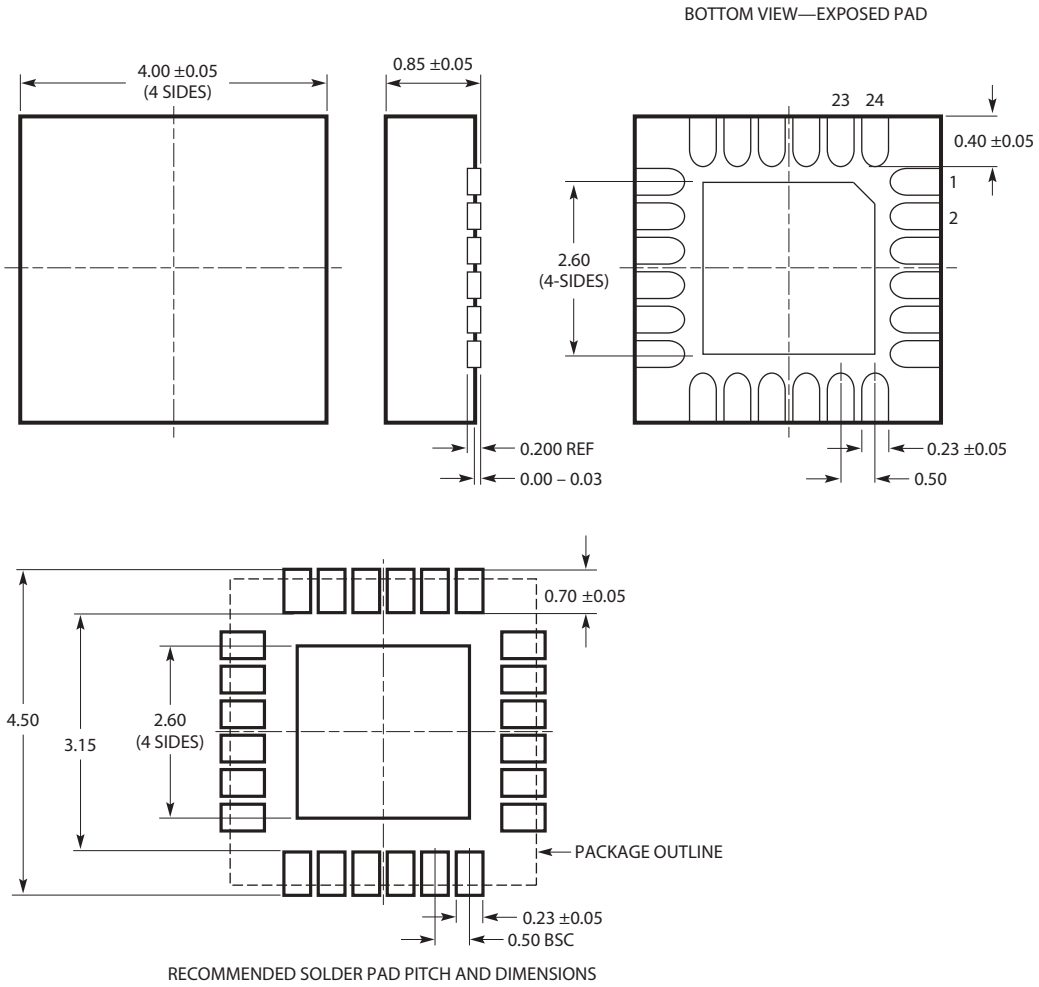
The LED current driver block is dedicated to drive 2 LEDs from the supply voltage (5 to 36 V) with a constant current of 2 mA each (current sink).

OP-Amp Blocks

Two general purpose OP-Amps allow the customer to built own I/O interfaces. The OP-Amps provide a rail-to-rail input and output.

PACKAGE OPTIONS

Part Number	Apex Package Style	Description
AIC1605ZC	ZC	24-pin QFN



ESD PROTECTION

The Requirements for Handling Electrostatic Discharge Sensitive Devices are described in the JEDEC standard JESD625-A. Please note the following recommendations:

- When handling the device, operators must be grounded by wearing a for the purpose designed grounded wrist strap with at least 1M? resistance and direct skin contact.
- Operators must at all times wear ESD protective shoes or the area should be surrounded by for ESD protection intended floor mats.
- Opening of the protective ESD package that the device is delivered in must only occur at a properly equipped ESD workbench. The tape with which the package is held together must be cut with a sharp cutting tool, never pulled or ripped off.
- Any unnecessary contact with the device or any unprotected conductive points should be avoided.
- Work only with qualified and grounded tools, measuring equipment, casing and workbenches.
- Outside properly protected ESD-areas the device or any electronic assembly that it may be part of should always be transported in EGB/ESD shielded packaging.

STORAGE CONDITIONS

The AIC1605 meets moisture sensitivity classification MSL2, according to JEDEC standard J-STD-020, and should be handled and stored according to J-STD-033.