SY5055

PFC+LLC Combo Controller

General Description

The SY5055 is a PFC+LLC combo controller, which integrates a Boost PFC controller and a resonant half-bridge controller.

The Boost converter works in CrM/DCM mode to minimize switching losses and get better EMI performance. Proprietary control is adopted to get unity PF and lowest THD. Burst function increases efficiency at low load. Reliable input BO/BI protection, Boost output OVP/UVP, over current protection, Boost feedback protection guarantees safety work.

The LLC converter with proprietary control achieves fast dynamic response and easy loop compensation parameters design. The peripheral devices count is greatly reduced to save BOM cost. The SY5055 also has Output OVP, OTP and OLP for safety operation.

Features

- PF>0.95, THD<5%
- Boost Quasi Resonant (QR) Operation
- Boost Burst Operation at Light Load
- LLC Fast Dynamic Response
- LLC Integrated Half-bridge Driver
- Input BO/BI Protection
- Boost Output, LLC Output OVP
- Cycle by Cycle Peak Current Protection
- Over Temperature Protection
- LLC Capacitive Mode Protection

Ordering Information

SY5055□(□□□)

Package Code

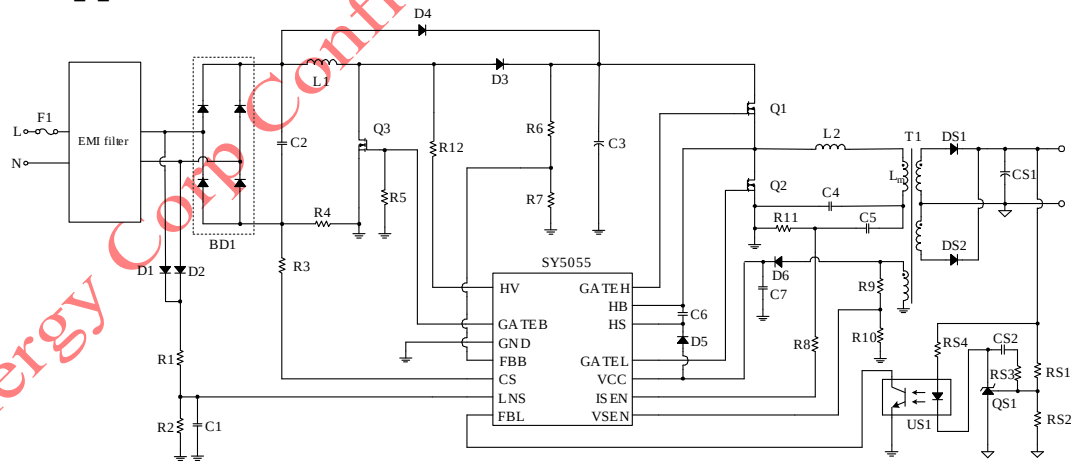
Optional Spec Code

Ordering Number	Package type	Note
SY5055FFP	SOP16	----

Applications

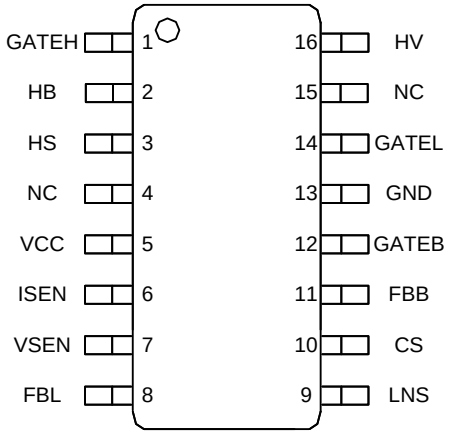
- LCD Television
- Desktop, All in One PC
- Adapter, Charger
- Printer

Typical Applications



Typical Applications

Pinout (top view)

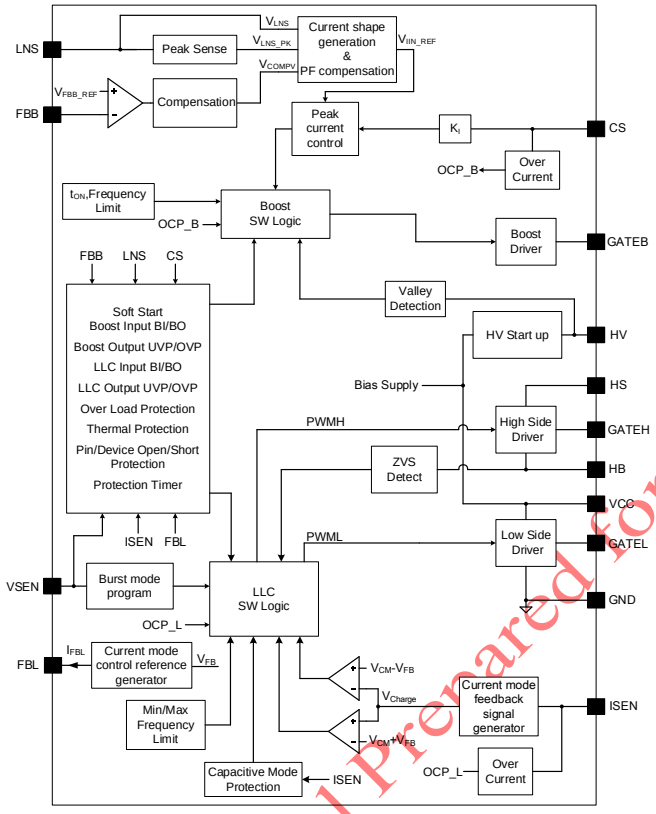


SOP16

Top Mark: EYF*xyz* (device code: EYF, ***x=year code, y=week code, z= lot number code*****)**

Pin number	Pin Name	Pin Description
1	GATEH	Half bridge controller high side drive pin.
2	HB	Half bridge controller high side ground pin.
3	HS	Half bridge controller high side bias supply pin.
4	NC	Not connected.
5	VCC	Bias supply pin.
6	ISEN	Half bridge controller resonant current sense pin.
7	VSEN	Half bridge controller output voltage sense pin.
8	FBL	Half bridge controller control input pin.
9	LNS	PFC controller input voltage sense pin.
10	CS	PFC controller input current sense pin.
11	FBB	PFC controller output feedback pin.
12	GATEB	PFC controller gate drive pin.
13	GND	Ground pin.
14	GATEL	Half bridge controller low side drive pin.
15	NC	Not connected.
16	HV	HV start-up pin.

Block Diagram



Block Diagram

Absolute Maximum Ratings (Note 1)

HV ---------- -0.3V ~ 650V
HB ---------- -3V ~ 650V
HS ---------- HB-0.3V ~ HB+30V
GATEH ---------- HB-0.3V ~ HB+15V
VCC ---------- -0.3V ~ 30V
I_{CS}(Note2) ---------- -10mA~+20mA
CS, ISEN ---------- -1.1V~+1.1V
FBB, LNS, FBL, VSEN ---------- -0.3V~3.6V
GATEB, GATEL ---------- -0.3V ~ 15V
Power Dissipation, @ T_A = 25°C SOP16---------- 1.02W
Package Thermal Resistance (Note 3)
SOP16, θ_{JA}---------- 122°C/W
SOP16, θ_{JC}---------- 11.5°C/W
Junction Temperature Range ---------- -45°C~150°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C ~ 150°C

Recommended Operating Conditions

VCC ---------- 10V~24V
HS-HB ---------- 9V~24V
Junction Temperature Range ---------- -40°C ~ 125°C
Ambient Temperature Range ---------- -40°C ~ 105°C

Electrical Characteristics

(V_{VCC} = 15V (Note 4), T_A = 25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VCC Pin Section						
VCC Turn-on Threshold	V_{VCC_ON}	Voltage rising	23	24	25	V
VCC Turn-off Threshold	V_{VCC_OFF}	Voltage falling	8.5	9	9.5	V
VCC Low for HV Start Threshold	V_{VCC_LO}		8.9	9.5	10	V
VCC Short Circuit Protection	V_{VCC_SCP}		0.6	0.8	1	V
VCC Shunt Voltage Protection	V_{VCC_Shunt}		25.4	26.4	27.4	V
VCC OVP Threshold	V_{VCC_OVP}		V_{VCC_Shunt}+ 0.4	V_{VCC_Shunt}+ 0.75	V_{VCC_Shunt}+ 1.1	V
VCC OVP Trigger Number of Switching Cycles	N_{VCC_OVP}			4		
Quiescent Current	I_Q		1.3	1.6	1.9	mA
Standby Current	I_{SDY}		300	400	500	μA
Enable Off Current	I_{ENOFF}			200	280	μA
VCC Max Shunt Current	I_{Shunt}	VCC>26V(Note5)	8	11	14.5	mA
VCC Fault Restart Timer	$T_{VCC\_timeout}$		0.69	1	1.1	s
HV Pin Section						
HV Start-up Current at VCC SCP	I_{ST_L}	VCC<0.7V	0.4	0.5	0.6	mA
HV Start-up Current at Normal State	I_{ST_N}		5.2	6	7	mA
Maximum Charge Time	T_{VCC_charge}		44	63	84	ms
Boost 2nd OVP Threshold	V_{HV_OVPTH}		480	505	530	V
HV OVP Number of Consecutive off Time for Trigger	N_{HV_OVP}			4		
QR dV/dt Sense Threshold	V_{HV_TH}	(Note 5)	24	40	56	V/μs
QR Time Out Time	T_{ZCS}		2.2	3.3	4.4	μs
FBB Pin Section						
Boost Output Regulation Reference	V_{FBB_REF}		1.18	1.2	1.22	V
Boost Output UVP Threshold	V_{FBB_UVP}	16.7% of Boost V_{out}	170	200	230	mV
Boost Output OVP Threshold	V_{FBB_OVP}	107.5% of Boost V_{out}	1.255	1.29	1.325	V
Boost & LLC Disable Threshold	V_{FBB_ENB}		2.05	2.3	2.5	V
LLC Input BO Threshold	V_{FBB_BO}		690	740	790	mV
LLC Input BI Threshold	V_{FBB_BI}		900	940	980	mV
Pin Open Detection Source Current	I_{FBB_OPEN}	For open pin	50	100	200	nA
CS Pin Section						
Boost Peak Current Limit	V_{CS_LIMIT}		-740	-700	-660	mV

Inductor Saturation or Short-circuit Protection Limit	V_{LS_LIMIT}		-900	-850	-800	mV
Inductor Saturation or Short-circuit Protection Trigger Number	$N_{LStimer}$			4		
Boost Current Sense Resistor Short Circuit Protection Threshold	V_{CS_RSCP}		-65	-50	-35	mV
Boost Current Sense Resistor Short Circuit Protection Timer	T_{CS_RSCP}			4		μs
Voltage Threshold at Boost Over Power Protection	V_{COMPV_OPP}			1.33		V
Calculate Coefficient of Boost Over Power Protection	K_{PFCOPP}			0.073		
Boost over Power Protection Timer	T_{COMPV_OPP}		180	256	290	ms
LNS Pin Section						
X-cap Maximum Discharge Time	T_{X_MAX}		44	63	82	ms
X-cap Discharge Debounce Time	T_{XDIS_DBT}		44	63	82	ms
Boost Input Brown Out Timer	$T_{PROT\_LNS\_BO}$		44	63	82	ms
Boost Input Brown Out Threshold	V_{LNS_BO}		374	395	425	mV
Boost Input Brown in Threshold	V_{LNS_BI}		450	472	495	mV
Pin Open Detection Source Current	I_{LNS_OPEN}		50	100	200	nA
GATEB Pin Section						
Drive Limit Voltage	V_{GATEB_DRV}		10.1	10.9	11.6	V
Drive Voltage within $T_{on,min.B}$	V_{GATEB_TH}			8.5		V
Source Current	I_{SOURCE_GATEB}	V_{GATEB}=8.5V	400	600	800	mA
Sink Current	I_{SINK_GATEB}	V_{GATEB}=2V	0.3			A
		V_{GATEB}=11V(Note 5)	1	1.4	1.8	A
Boost Minimum ON Time	$T_{ON\_MIN\_B}$		200	300	400	ns
Boost Maximum ON Time	$T_{ON\_MAX\_B}$		20	30	40	μs
Boost Minimum OFF Time	$T_{OFF\_MIN\_B}$		0.7	1	1.5	μs
Boost Maximum OFF Time	$T_{OFF\_MAX\_B}$		20	30	40	μs
Toffmax if CS<-850mV and within $T_{LLC,delay}$	T_{offmax}		70	100	130	μs
Boost Minimum Switching Period	$T_{SW\_MIN\_B}$		2	2.9	4	μs
FBL Pin Section						
Open Loop Protection Threshold Current	$I_{FBL\_225\%}$		12	23	33	μA

Open Loop Protection Trigger Time	T_{OLP}		46	63	89	ms
Overpower Protection Trigger Time	T_{OPP}		179	256	290	ms
Max off Time for DCM Mode	T_{offmax_DCM}	R_{ISENSE} +R_{ISEN}=82Ω		1.67		μs
		$R_{ISENSET}$ +R_{ISEN}=160Ω		2.5		μs
		$R_{ISENSET}$ +R_{ISEN}=285Ω		3.3		μs
		$R_{ISENSET}$ +R_{ISEN}=475Ω		5		μs
Regulated Burst Frequency for Burst Mode	F_{Burst}		0.85	1	1.4	kHz
ISEN Pin Section						
Resonant Current Sample Resistor Calculate Coefficient	k	$R_{ISENSET}$ +R_{ISEN}=82Ω		4.1×10^{-7}		
		$R_{ISENSET}$ +R_{ISEN}=160Ω		6.15×10^{-7}		
		$R_{ISENSET}$ +R_{ISEN}=285Ω		8.21×10^{-7}		
		$R_{ISENSET}$ +R_{ISEN}=475Ω		1.23×10^{-6}		
LLC Current Sense Resistor Short Circuit Protection Threshold	V_{ISEN_RSCP}		30	50	80	mV
LLC Current Sense Resistor Short Circuit Protection Timer	T_{ISEN_RSCP}			4		μs
ISEN Max Current Limit	V_{ISEN_L}	R_{GATEB}=30kΩ	±600	±660	±720	mV
		R_{GATEB}=18kΩ	±700	±760	±820	mV
		R_{GATEB}=10kΩ	±8000	±860	±920	mV
ISEN Max Current Limit Protection Timer	$T_{IL\_protect}$		20	32	44	ms
VSEN Pin Section						
LLC Output OVP Counter	N_{OVP_COUNT}			4		
LLC Output OVP Reference	V_{VSEN_OVP}		1.42	1.47	1.54	V
LLC Disable Threshold	V_{VSEN_ENB}		1.8	2.2	2.5	V
LLC Output UVP Reference	V_{VSEN_UVP}		370	397	425	mV
LLC Output UVP Timer	T_{VSEN_UVP}		22	32	44	ms
Pin Open Detection Source Current	I_{VSEN_OPEN}		50	100	200	nA
GATEL Pin Section						
Drive Limit Voltage	V_{GATEL_DRV}		10.5	11.5	12.5	V
Source Current	I_{SOURCE_GATEL}	V_{GATEL}=4V	200	350	500	mA
Sink Current	I_{SINK_GATEL}	V_{GATEL}=2V	0.3			A
		V_{GATEL}=11V	1	1.4	1.8	A
LLC Minimum on Time	$T_{ON\_MIN\_L}$		250	400	550	ns
LLC Maximum on Time	$T_{ON\_MAX\_L}$		12	20	28	μs
Bootstrap Charge Time	T_{BST}		3	5	7	μs
HB Pin Section						
dV/dt Threshold for HB ZVS	dV/dt_{ZVS}	(Note 5)	52	80	108	V/μs
Minimum Dead Time for ZVS	T_{D_MIN}		120	185	250	ns

Maximum Dead Time for ZVS	T_{D_MAX}		0.8	1	1.2	μs
HS Pin Section (Signal Refer to HB)						
HS Turn-on Threshold	V_{HS_ON}		6.5	7.5	8.5	V
HS Turn-off Threshold	V_{HS_OFF}		5.8	6.4	7.1	V
HS Quiescent Current	I_{Q_HS}		10	20	50	μA
GATEH Pin Section (Signal Refer to HB)						
Drive Limit Voltage	V_{GATEH_DRV}		10.5	11.5	12.6	V
Source Current	I_{SOURCE_GATEH}	V_{GATEH}-V_{HB}=4V	200	350	500	mA
Sink Current	I_{SINK_GATEH}	V_{GATEH}-V_{HB} =2V	0.3			A
		V_{GATEH}-V_{HB} =11V	1	1.4	1.8	A
Thermal Section						
Thermal Shut Down Temperature	T_{SD}	(Note 5)		150		℃
Thermal Shut Down Temperature Hysteresis	T_{SD_HSY}	(Note 5)		20		℃

Note 1: Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

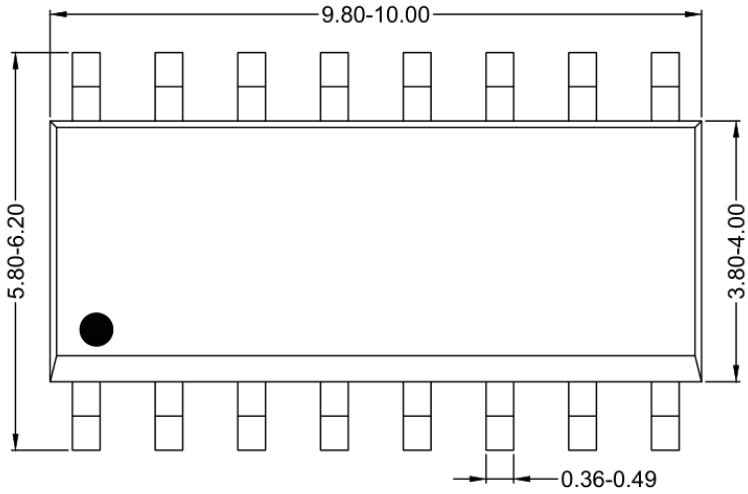
Note 2: The IC internal diode will clamp the voltage of CS pin. During the IC operating, Ics should not exceed -10mA if Vcs reaches -1.1V.

Note 3: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

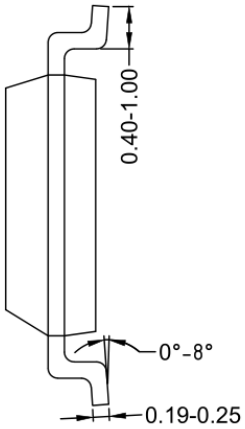
Note 4: Increase VCC pin voltage gradually higher than V_{VCC_ON} voltage then turn down to 15V.

Note 5: Guaranteed by design.

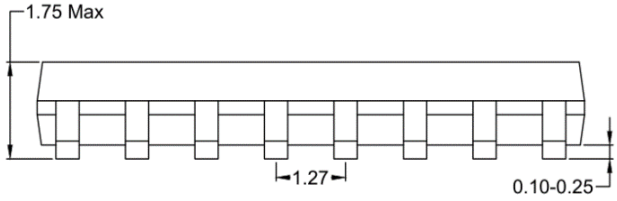
SOP16 Package Outline & PCB Layout



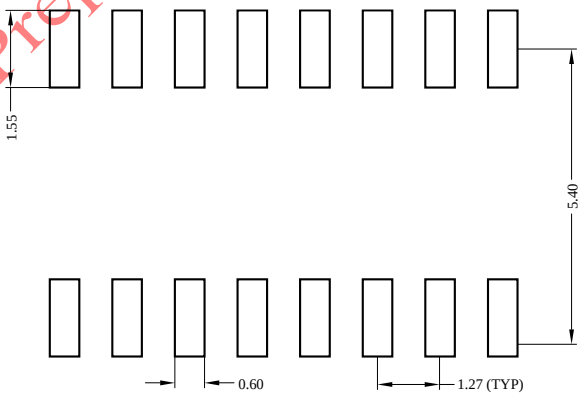
Top View



Side View



Front View



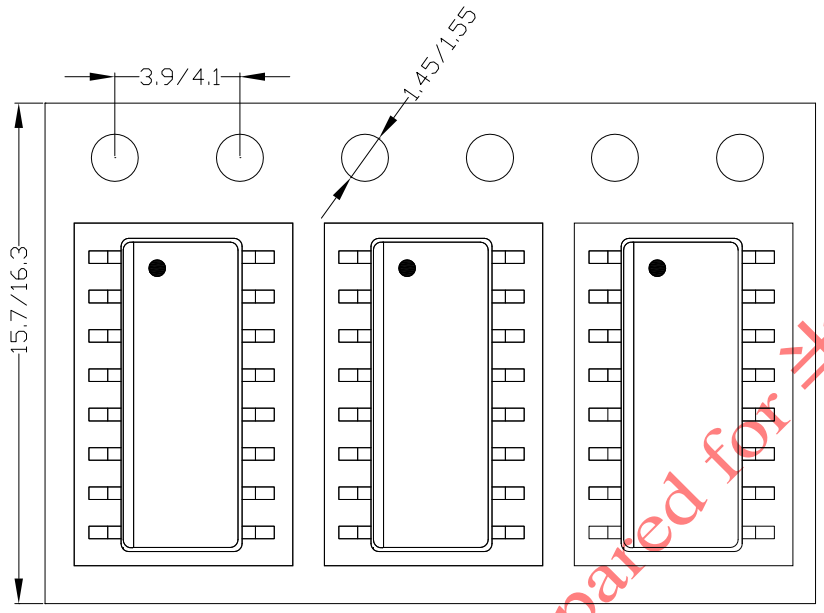
Recommended PCB layout

Notes: All dimension in millimeter and exclude mold flash & metal burr.

Taping & Reel Specification

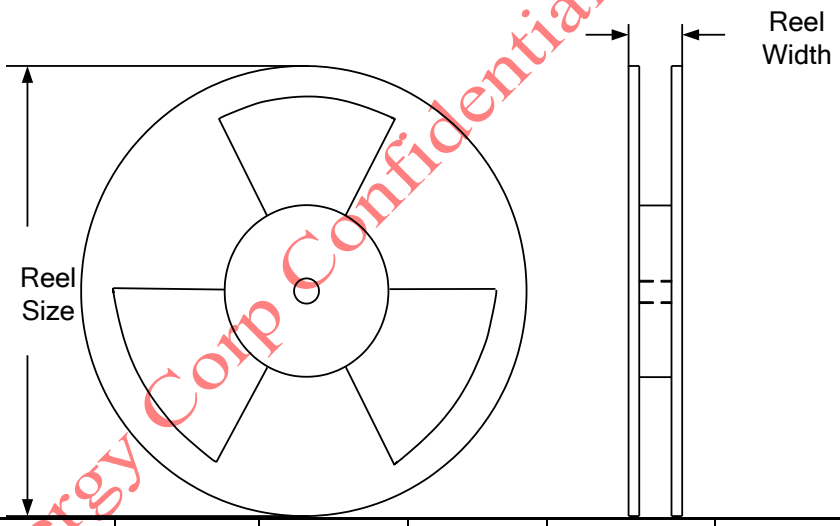
1. Taping orientation

SOP16



Feeding direction ⟶

2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Reel width(mm)	Trailer length(mm)	Leader length (mm)	Qty per reel
SOP16	16	8	13"	12.4	400	400	2500

3. Others: NA