ON Semiconductor®

Thick-Film Hybrid IC

# **Single-phase rectification Active Converter Hybrid IC**

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#### Overview

This IC is average current control type Active Converter Hybrid IC for power factor improvement of single-phase AC power supply, that containing power devices of step-up active converter, control IC over-current and over-voltage protection circuits.

#### **Applications**

• Single-phase rectification active filter for power rectification for air conditioners and general-purpose inverters.

#### **Features**

- Power switching device for active converter is adopting IGBT.
- Soft start functions and the over current, the over voltage, and the low-voltage are including as protection circuit
- Capable of controlling ON/OFF by logic level input signal.
- Output voltage changeability functions by control signal.

# **Specifications**

# **Absolute Maximum Ratings** at Ta = 25°C

Parameter		Symbol	Conditions		Ratings	unit	
IGBT	Collector-emitter voltage		VCE			600	V
(TR1+TR2)	Repetitive peak collector current		ICP		*1	300	Α
	Collector current		IC			105	Α
	Power dissipation	Power dissipation				156	W
FRD1 Diode reverse voltage		je	VRM			600	V
(D1)	Repetitive peak forward current		IF1P		*1	110	Α
	Diode forward current		IF1			36	Α
	Power dissipation		PD1			75	W
FRD2 Repetitive peak forward curren		ard current	IF2P		*1	15	Α
(D2)	Diode forward curre	nt	IF2			7	Α
	Power dissipation		PD2			13	W
Supply voltage (V <sub>CC</sub> -GND)		VCC			20	V	
Signal pin input voltage Pin 4 Pin 5		VIS			-10 to 0.3		
		VCOMP					
	Pin 8 Pin 9 Pin 2 Pin 6		VFB	1		-0.3 to 6.5	
			VOVP	1			V
			VONF			1	
			Vctl	1		-0.3 to V <sub>CC</sub>	
Maximum in	put AC voltage		VAC	Single-phase Full-rectified		264	V
Maximum o	utput voltage		٧o	Under the Application condition		450	V
Maximum o	Maximum output power		Wo	(VAC=200V)	ļ	6	kW
Input AC current (normal condition)		I <sub>IN</sub>	1	ļ	30	Arms	
Junction temperature		Tj			150	°C	
Operating case temperature		Tc	HIC case temperature	*2	-20 to +100	°C	
Storage temperature		Tstg			-40 to +125	°C	
Tightening torque			A screw part	*3	1.17	N•m	
Withstand voltage		VINS	50Hz sine wave AC 1minute	*4	2000	VRMS	

#### [Note]

- \*1: Duty ratio D = 0.1, tp = 1ms
- \*2: Measure point is between 5mm to center of back.
- \*3: Torque should be set within 0.79 to 1.17N·m. Flatness of the heat-sink should be lower than 0.2mm.
- \*4: The test condition: AC2500V, 1 second.

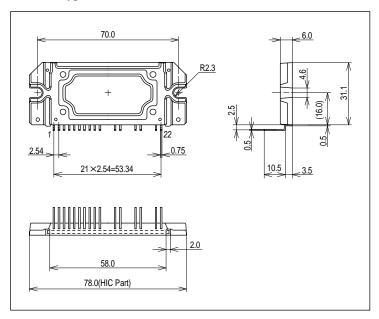
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

# **Electrical Characteristics** at Tc = 25°C, $V_{CC} = 15.0V$ : Unless otherwise noted

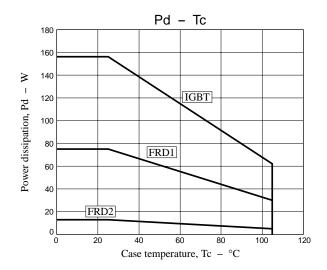
Danier	Symbol	Conditions	Test circuit	Ratings			
Parameter	Symbol			min	typ	max	unit
Power output part							
Collector-emitter leak current (IGBT)	ICES	VCE = 600V	Fig.1			200	μΑ
Collector-emitter saturation voltage (IGBT)	V <sub>CE</sub> (sat)	I <sub>C</sub> = 40A	Fig.2		1.2	1.8	٧
Diode reverse current (FRD1)	I <sub>R</sub>	V <sub>R</sub> = 600V	Fig.1			200	μΑ
Diode forward voltage (FRD1)	V <sub>F</sub> 1	I <sub>F</sub> = 40A	Fig.3		2.2	2.8	V
Diode forward voltage (FRD2)	V <sub>F</sub> 2	I <sub>F</sub> = 5A	Fig.3		2.5	3.5	V
Junction to case thermal resistance	θј-с1	IGBT (TR1+TR2)			0.80		°C/W
	θј-с2	FRD1 (D1)			1.65		°C/W
	θј-с3	FRD2 (D2)			9.0		°C/W
Control IC part	- U	•	II.		L. L.		
Control IC input current	I <sub>CC</sub> (ON)	V <sub>CC</sub> = 15V, VONF = 5V			14	20	mA
	I <sub>CC</sub> (OFF)	V <sub>CC</sub> = 15V, VONF = 0V			2.5	5	
Oscillation frequency	fosc	V <sub>CC</sub> = 15V, VONF = 5V	Fig.4	19.5	22.0	24.5	kHz
Open loop protection threshold voltage	VOLP			0.8	0.95	1.1	٧
Error-amp reference voltage	Vref			4.88	5.0	5.12	V
Peak current protection threshold voltage	VIS(PK)		Fig.5	-0.58	-0.5	-0.42	٧
Over voltage protection threshold voltage	VOVP(ON)		Fig.6	5.095	5.3	5.51	V
ON/OFF threshold voltage	VTHON	V <sub>CC</sub> = 15V		3.0			V
	VTHOFF		Fig.7			0.5	٧
Start-up V <sub>CC</sub> voltage	V <sub>CC</sub> (ON)	VONF = 5V		12.4	13.25	14.1	٧
Shut-down V <sub>CC</sub> voltage	V <sub>CC</sub> (OFF)		Fig.8	9.4	10.0	10.7	٧
Substrate temperature monitor resistance	RTH	Resistance between VTH-GND	Fig.3	90	100	110	kΩ
Application circuit : VAC = 200V, VO =	: 380V (Vctl = 1.5	507V)	· · · · · · · · · · · · · · · · · · ·				
Output voltage	v <sub>O</sub>	Wo = 2kW		366	380	394	V
Power Factor	cosφ	Wo = 400W	Fig.9	0.98	0.99		
		Wo = 2kW	1	0.99	0.995	1.0	

# **Package Dimensions**

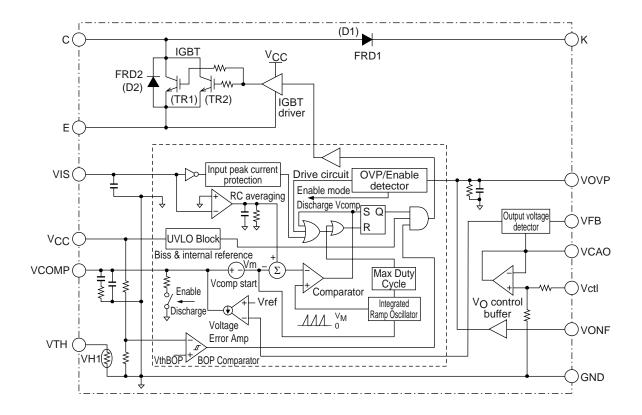
unit:mm (typ)



# IGBT (TR1+TR2), FRD1 (D1) & FRD2 (D2) vs. Temperature Derating (Ta = 25°C)



# **Block Diagram**



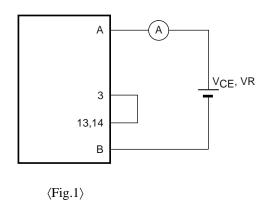
**Explanation of Terminal** 

Terminal No.	Symbol	Explanation
1	Vcc	Control IC power supply input
2	VONF	ON/OFF control terminal
3	GND	Signal GND
4	VIS	Current detection terminal
5	VCOMP	Phase compensation terminal (Voltage error amplifier out)
6	Vctl	Output voltage control signal input
7	VCAO	Output voltage control amplifier output
8	VFB	Output voltage feed back terminal
9	VOVP	Over voltage protection terminal
10	VTH	Terminal of thermistor TH1
11, 12	-	An empty terminal
13, 14	Е	IGBT (TR1+TR2) Emitter
15, 16	-	An empty terminal
17, 18	С	IGBT (TR1+TR2) Collector
19, 20	-	An empty terminal
21, 22	К	FRD1 (D1) Cathode

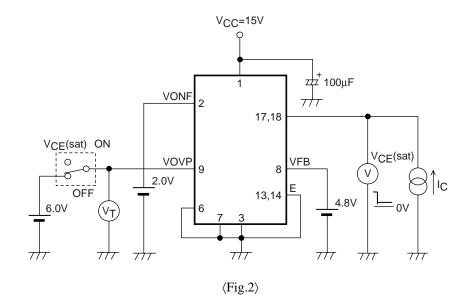
# **Test Circuit -1**

# (1) ICES, $I_R$

	IGBT	FRD1
А	17, 18	21, 22
В	13, 14	17, 18



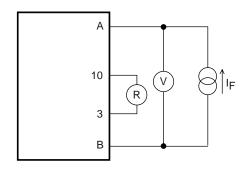
# (2) V<sub>CE</sub>(sat) (Test by Pulse)



 $\langle Fig.3 \rangle$ 

# (3) V<sub>F</sub>1, V<sub>F</sub>2 (Test by Pulse), RTH

	FRD1	FRD2
Α	17, 18	13, 14
В	21, 22	17, 18

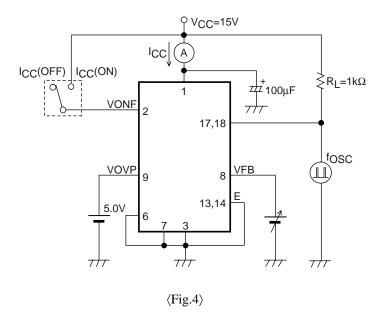


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# **Test Circuit -2**

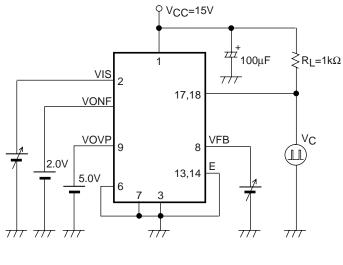
# (4) I<sub>CC</sub>(ON)/I<sub>CC</sub>(OFF), VOLP, f<sub>OSC</sub>

Icc, fosc	VOLP
VFB = 1.1V	VONF = 5.0V



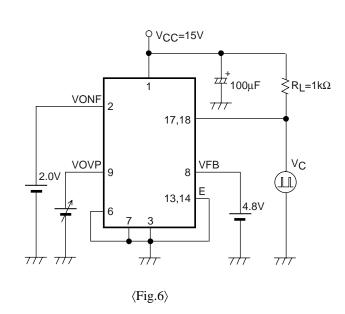
#### (5) Vref, VIS(PK)

Vref	VIS(PK)
VIS = -0.6V	VFB = 4.8V



 $\langle Fig.5 \rangle$ 

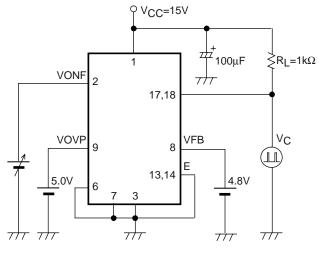
#### (6) VOVP(ON)



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# **Test Circuit -3**

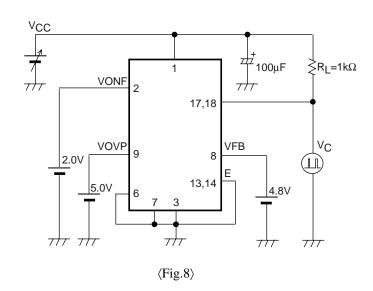
#### (7) VTHON, VTHOFF



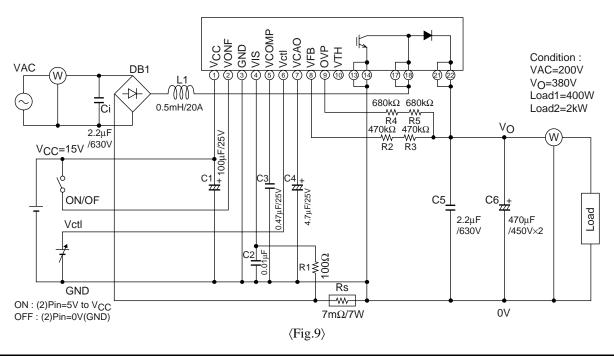
⟨Fig.7⟩

#### (8) $V_{CC}(ON)$ , $V_{CC}(OFF)$

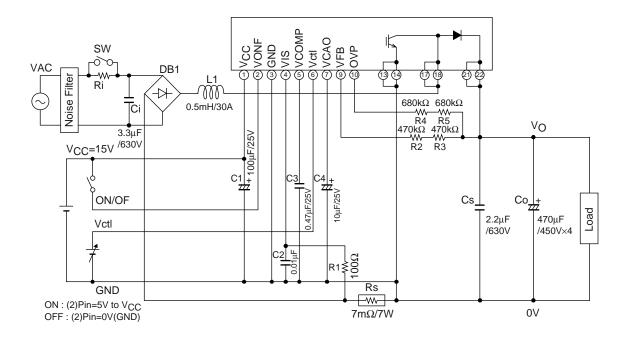
V <sub>CC</sub> (ON)	V <sub>CC</sub> (OFF)
Vc-ON	Vc-OFF



#### (9) Power Factor (COS\$\phi\$)



# **Application Circuit**

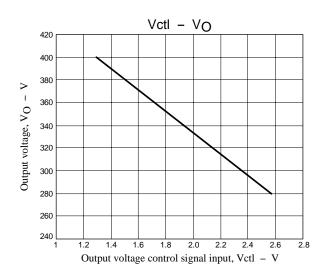


#### **Recommended Condition**

Parameter	Symbol	Conditions	Ratings	unit
AC Voltage	VAC	50/60Hz	170 to 264	Vrms
Output voltage	VO		VAC×√2+(10 to 15)≤450	V
Over-voltage detection voltage	VOV		V <sub>OUT</sub> +(10 to 20)	V
Control IC supply voltage	VCC	V <sub>CC</sub> -GND	14.5 to 17.0	V
Inductor	L1		0.5	mH
Input film capacitor	Ci		3.3≤Ci	μF
Output film capacitor	Cs		2.2≤Cs	μF
Output electrolytic capacitor	Co		1880≤Co	μF

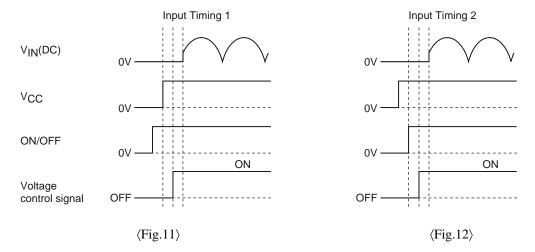
#### **Output Voltage Control**

Output voltage control signal Vctl sets referring to the Vctl-VO characteristic of the figure below.

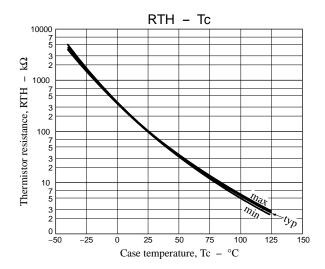


# **Timing Chart**

Even if power supply and signal at any timing are input, this IC is not destroyed. However, soft start circuit doesn't operate when  $V_{IN}(DC)$  is input at the timing of Figure 11 and 12. Therefore, overcurrent protection circuit will operate, and audio frequency noise from coil may generate. Please turn on ON/OFF or  $V_{CC}$  after  $V_{IN}(DC)$  to avoid this.



# The built-in thermistor resistance temperature characteristic



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