Features

- Compact solid-state bidirectional SiC MOSFETs
- Breakdown voltage V_{OFF} up to 1500V@IDSS=100uA
- Low output leakage current, I_O=1uA@V_{DS}=1000V
- Low on-resistance, R_{ON}(Typ)=100 Ω @I_O=2mA
- Low turn on time: T_{ON}<50us
- Low turn off time: T_{OFF}<200us
- 7-V reverse breakdown voltage handling capability
- Stretched WB SOIC-12 package with >8 mm creepage and clearance
- CTI:>500V
- Temperature range: –40°C to +125°C
- Safety Approval:
  - — DIN VDE 0884-17:2021-10
  - — UL 1577 component recognition program
  - — CQC Gb4943.1-2022
- AEC-Q100 Qualified

Applications

- Battery/motor/solar panel insulation resistance measurement/leakage detection
- Sensing in high voltage application
- Electro mechanical relay replacement
- Inrush current limiter protection

General Description

Pai8558EQ is an opto compatible solid state relay developed based on Rongpai's unique isolation technology and mature standard semiconductor CMOS process. The device contains two SiC MOSFETs with bidirectional current up to 30mA and peak current up to 50mA.

The input is isolated from the output by a 5kVRMS isolation barrier. It integrates a gate driver which controls the opening and closing of the two MOSFETs on the output. The output switch is turned on when the input current exceeds 7mA, and turned off when the input voltage is lower than 0.4V.

The device uses a standard wide-body WB SOIC-12 package that provides 5kVrms and 10kVpeak insulation and extremely high reliability.

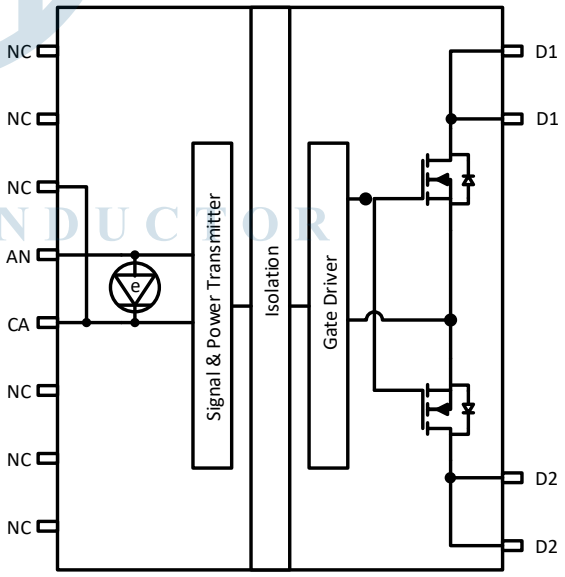


Fig.1 Functional Block Diagram

Pin Configurations and Functions

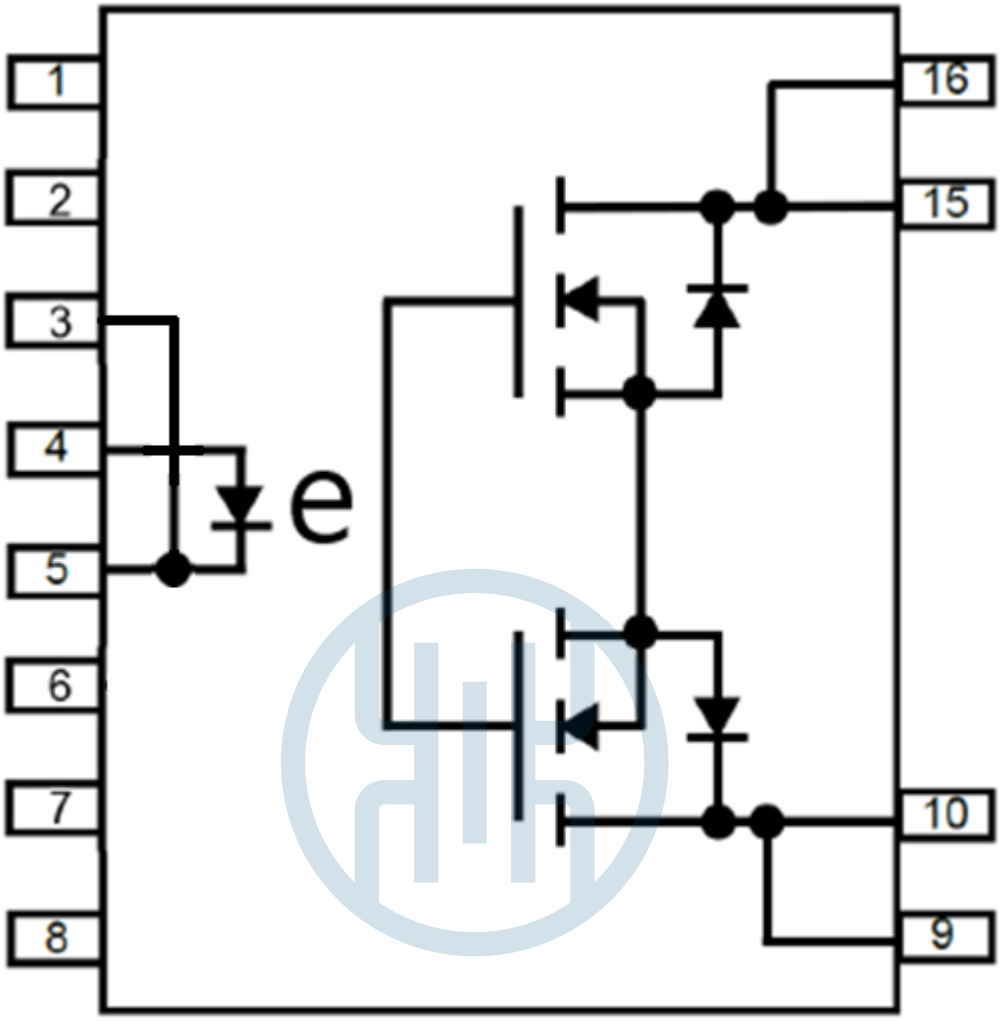


Fig 2. Pin Configuration

Table 1.Pai8558EQ Pin Function Descriptions

PIN NO.	PIN NAME	TYPE	DESCRIPTION
1,2,6,7,8	NC	-	No connection.
3	NC	-	Do not connect (internally connected to Pin 5).
4	AN	I	Anode.
5	CA	I	Cathode.
9,10	D2	O	Drain1.
15,16	D1	O	Drain2.

Specifications

Absolute Maximum Ratings

Table 2.Absolute Maximum Ratings (T_A = 25°C, unless otherwise noted.)

Parameter	Symbol	Condition	Min	Max	Unit
Average input current	$I_{F(avg)}$	T_A=-40°C to 125°C		30	mA
Surge input current	$I_{F(surge)}$	f=1Hz,50% duty		60	mA
Peak transient input current	I_{FP}	f=100Hz, duty cycle=0.1%		1	A
Reverse input voltage	BV_R	T_A=-40°C to 125°C		7	V
Input power dissipation	P_{IN}			65	mW
Output load current	I_O	T_A=-40°C to 125°C		50	mA
Output avalanche current	I_{AV}	tm = 1 min, duty cycle = 0.1%, cumulative of 5 mins over lifetime		0.6	mA
Output power dissipation	P_O			1000	mW
Junction temperature, T_J	T_J		-40	150	°C
Ambient temperature, T_A	T_A		-40	125	°C
Storage temperature, T_{stg}	T_{stg}		-55	150	°C

1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ESD Ratings

Table 3.ESD Ratings

Model	Symbol	Condition	Min	Max	Unit
Human-body model	HBM	Per AEC Q100-001	2000		V
Charge-device model	CDM	Per AEC Q100-005	750		V

Recommended Operating Conditions

Table 4.Recommended Operating Conditions (Over operating free-air temperature range (unless otherwise noted)

Symbol	Description	MIN	MAX	UNIT
$I_{F(ON)}$	Input current(ON)	7	20	mA
$V_{F(OFF)}$	Input voltage (OFF)	-5	0.4	V
V_O	Continuous load voltage		1000	V
I_O	Load current	–10	10	mA
T_A	Ambient Temperature	-40	125	°C

Insulation Specifications

Table 5.Insulation Specifications

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
V_{IORM}	Maximum working insulation voltage			1414		V_{PEAK}
V_{IOTM}	Transient overvoltage	Transient Overvoltage, t_{ini} = 60 sec	7071			V_{PEAK}
V_{ISO}	Input-Output Momentary Withstand Voltage	RH ⩽ 50%, t_m = 1 minute; T_A = 25°C	5000			V_{RMS}
V_{IOSM}	Surge voltage	Tested per VDE0884-11 with surge voltage of 1.2 µs/50 µs tested with magnitude 6250 V x 1.6 = 10 kV	6250			V_{PEAK}
R_S	Insulation Resistance at T_S	V_{IO} = 500 V	10^9			Ω
R_{I-O}	Input-Output Resistance	V_{I-O} = 1000 VDC	10^9	10^{14}		Ω
C_{I-O}	Input-Output Capacitance	f = 1 MHz; V_{I-O} = 0 V_{DC}		0.6		pF

Specifications

Electrical Characteristics

Table 6.ELECTRICAL CHARACTERISTICS

Typical value is tested under T_A = 25°C， IF=10mA, unless otherwise specified .

Symbol	Parameter	Test condition	Min	Typ	Max	Unit	Fig.
V_R	Input reverse breakdown voltage	I_R=10uA	5			V	
$V_{F(ON)}$	Input forward voltage	I_F=10mA	1.9	2.0	2.2	V	
$V_{F(OFF)}$	Input-forward voltage(OFF)				0.4	V	
$I_{F(ON)}$	Input current(ON)		1		7	mA	
$\|V_{O(OFF)}\|$	Output withstand voltage	I_O = 100 μA, T_A = 25°C	1500			V	
$I_{O(OFF)}$	Output leakage current	V_O = 1000V， T_A = 25°C			1000	nA	
		V_O = 1000V， T_A = 125°C			1000	nA	
C_{OUT}	Output capacitance	V_O = 0 V, f = 1MHz		2.5		pF	
R_{ON}	Output Resistance	I_O=2mA		120	250	Ω	

Switching Characteristics

Table 7.Switching Characteristics

Typical value is tested under T_A = 25°C， IF=10mA, unless otherwise specified .

Symbol	Parameter	Test condition	Min	Typ	Max	Unit	Fig.
T_{ON}	Turn-on time	I_F=10mA, V_{DD}=40V, R_{LOAD}=20kΩ	5	15	50	us	
T_{OFF}	Turn-off time	V_{DD}=40V, R_{LOAD}=20kΩ	10	64	200	us	

Typical Characteristics Curves

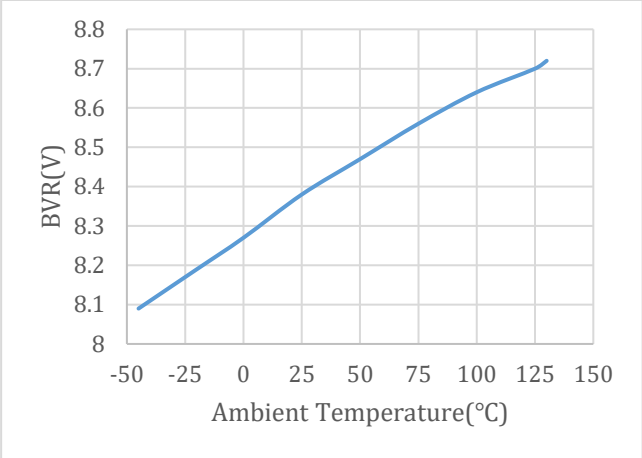


Fig3. BVR vs Ambient Temperature

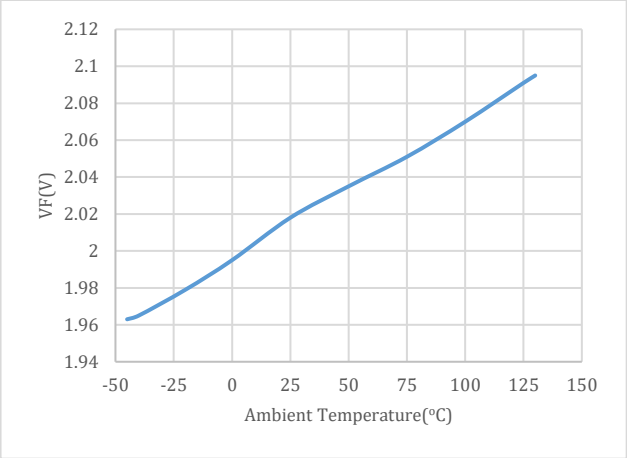


Fig4. Forward voltage vs Ambient Temperature

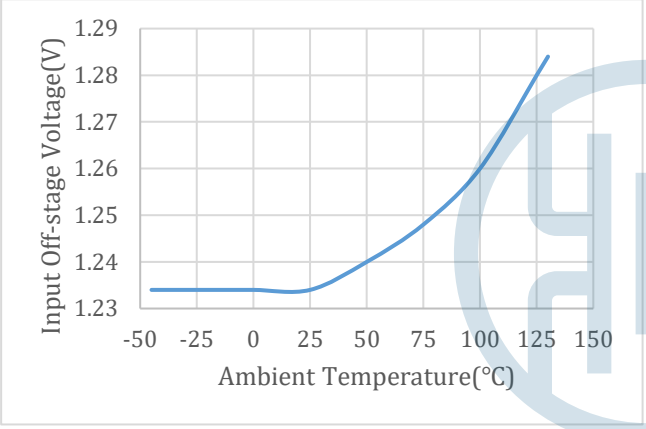


Figure 5 VF(OFF) vs Ambient Temperature

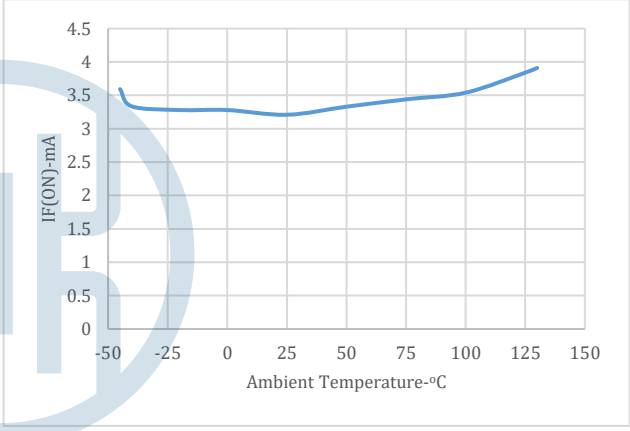


Figure 6 IF(ON) vs Temperature

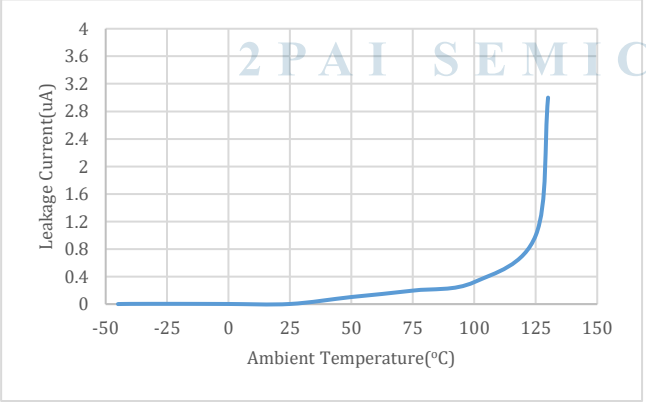


Figure 7 Leakage Current vs Ambient Temperature

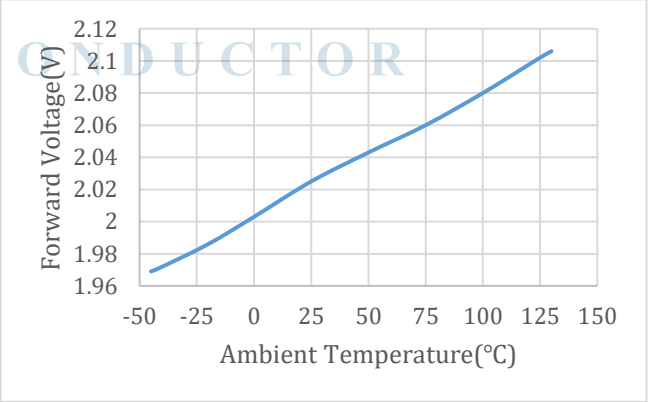


Figure 8 Forward voltage (VF) vs Temperature

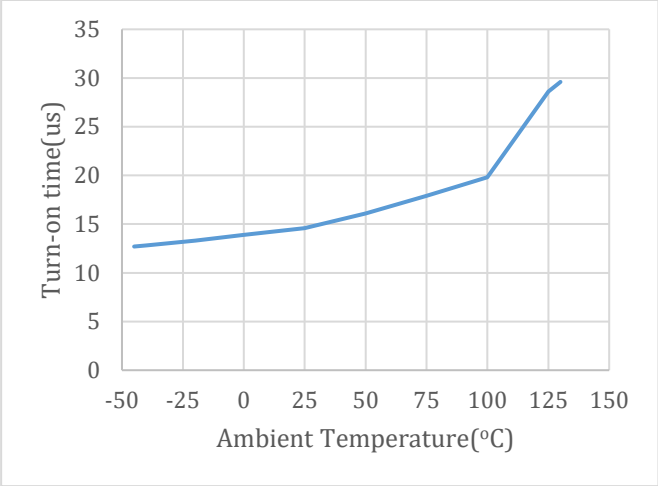


Fig9.Turn-on time vs Ambient Temperature

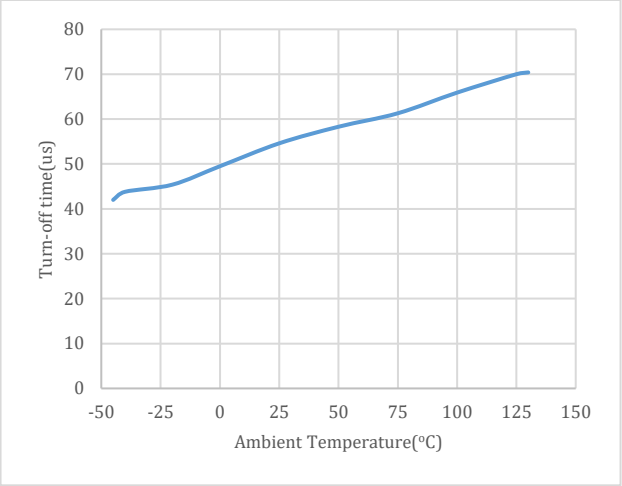


Fig10.Turn-off time vs Ambient Temperature

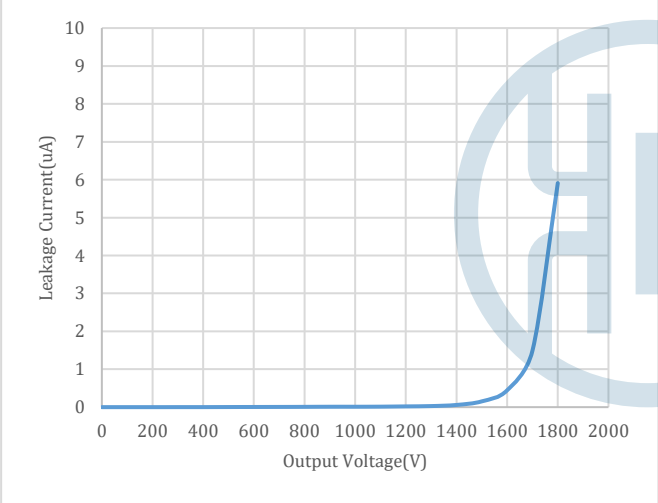


Figure 11 Leakage Current vs Output Voltage

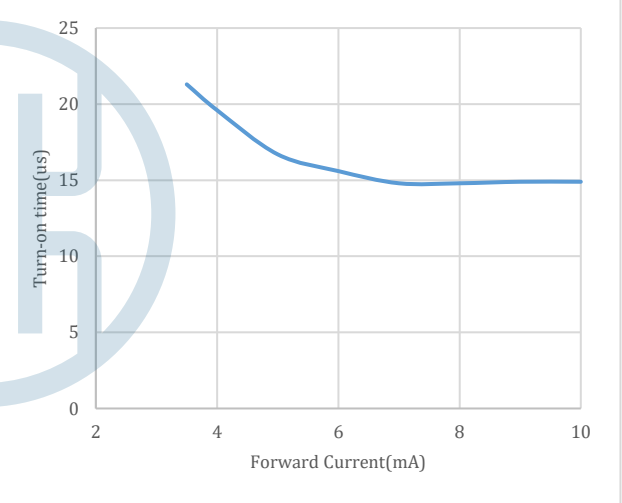


Figure 12 Turn-on time vs Forward Current

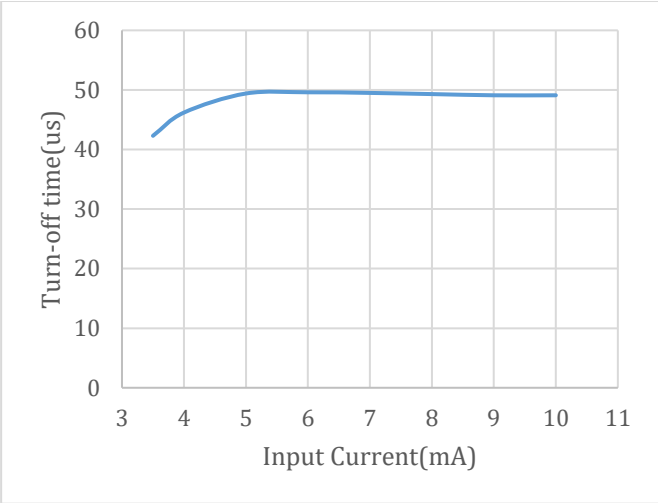


Figure 13 Turn-off time vs Forward Current

Fig15.Switching Time Test Circuit and Waveform

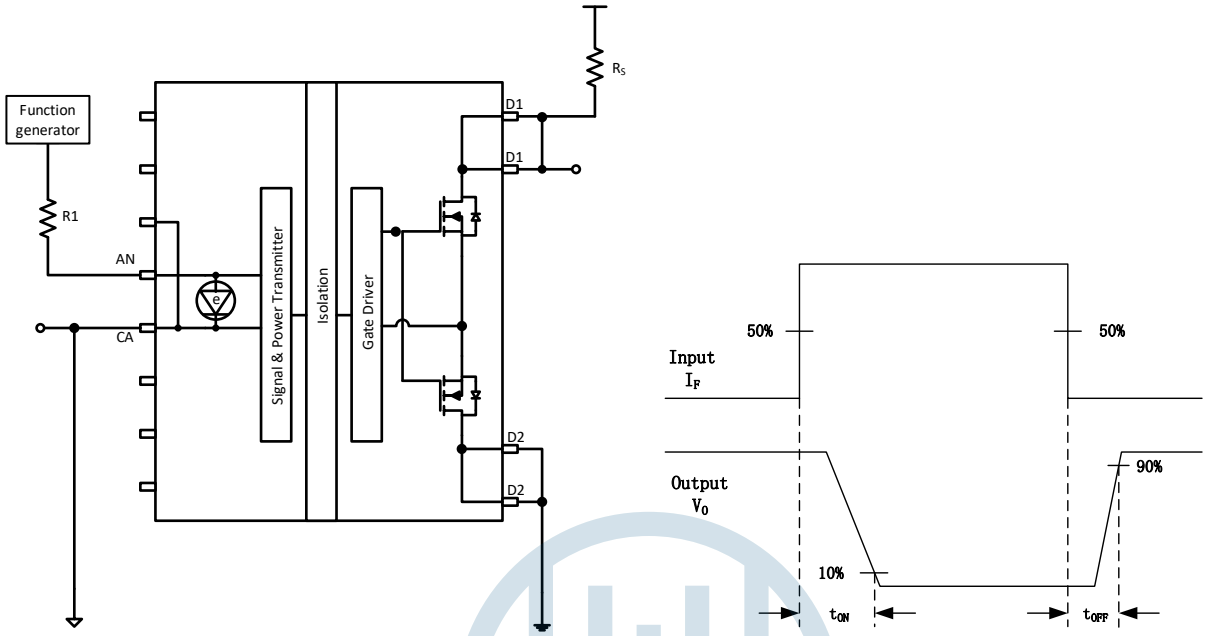
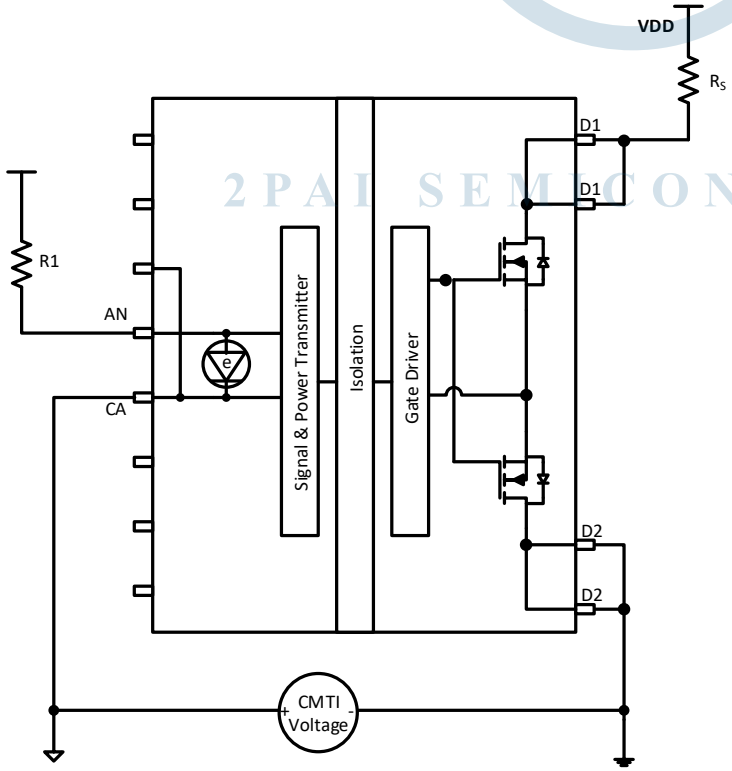


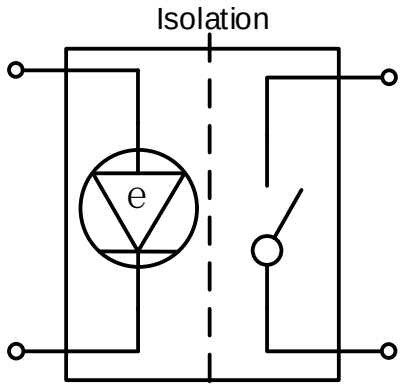
Fig16.CMTI Test Circuit



Application Information

PAI8558EQ is a single channel isolated solid relay that is functionally equivalent a opto-coupler relay as shown in fig17. It functions like a bidirectional switch with no output power requirement. The input side is driven through an input voltage higher than 2.1V which can totally makes the output side in on-state. The recommended input current is 7mA to 20mA.

Figure 17 Pai8558EQ Equivalent Circuit

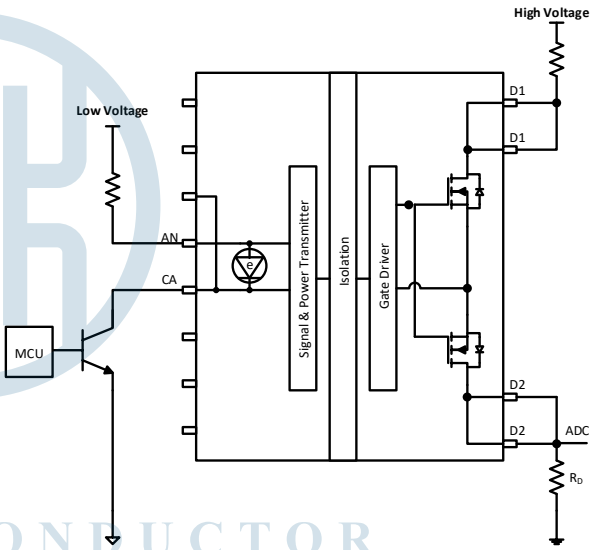


The input side energy is dilivered through an on-chip power transfer block, and implement a driver circuitry to switch two inner high-voltage SiC MOSFETS. When sufficient current is driven into current input side controller, the internal power delivery circuit will be enabled. Then the energy in the input side will be dilivered to the output side to supply output side drive circuitry to switch the inner two high-voltage SiC MOSFETS.

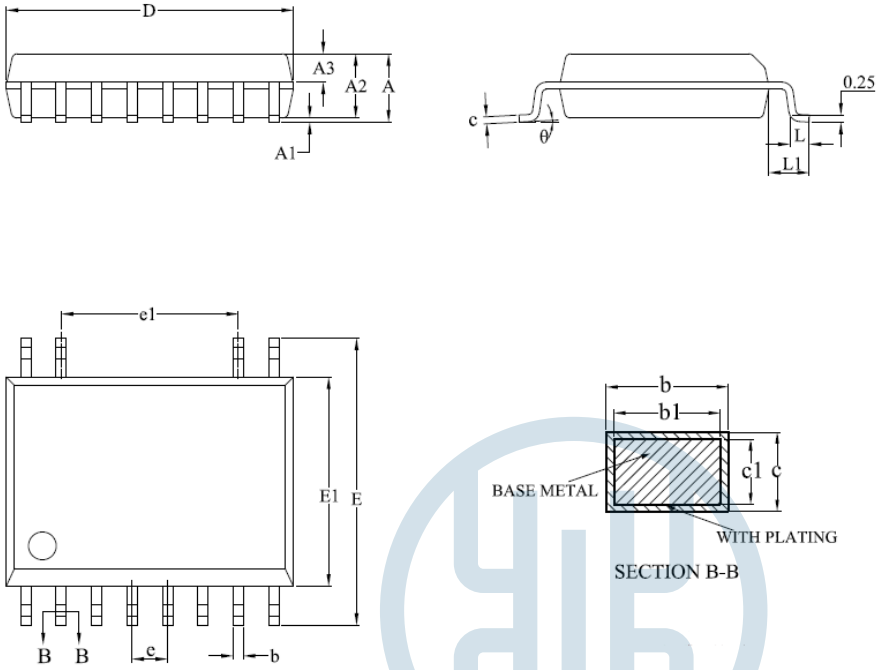
A typical application circuit (Figure 18) shows the PAI8558EQ's input being controlled by the microprocessor to switch the output (high voltage side).

The Pai8558EQ 's galvanic isolation protects the low voltage side of the circuit (input) from the high-voltage side (output). Pins 9 and 10 are internally connected , and 15 and 16 are internally connected too. It is recommended to shorting pin9 to pin10, as well as pin15 to pin16 while routing the PCB layout.

Figure 18 Typical Application Circuit



Package Dimension



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	2.65
A1	0.10	—	0.30
A2	2.25	2.30	2.35
A3	0.97	1.02	1.07
b	0.35	—	0.43
b1	0.34	0.37	0.40
c	0.25	—	0.29
c1	0.24	0.25	0.26
D	10.20	10.30	10.40
E	10.10	10.30	10.50
E1	7.40	7.50	7.60
e	1.27BSC		
e1	6.35BSC		
L	0.55	—	0.85
L1	1.40REF		
θ	0	—	8°

Fig 20. Outline Package for Pai855xE(Q)

Land pattern

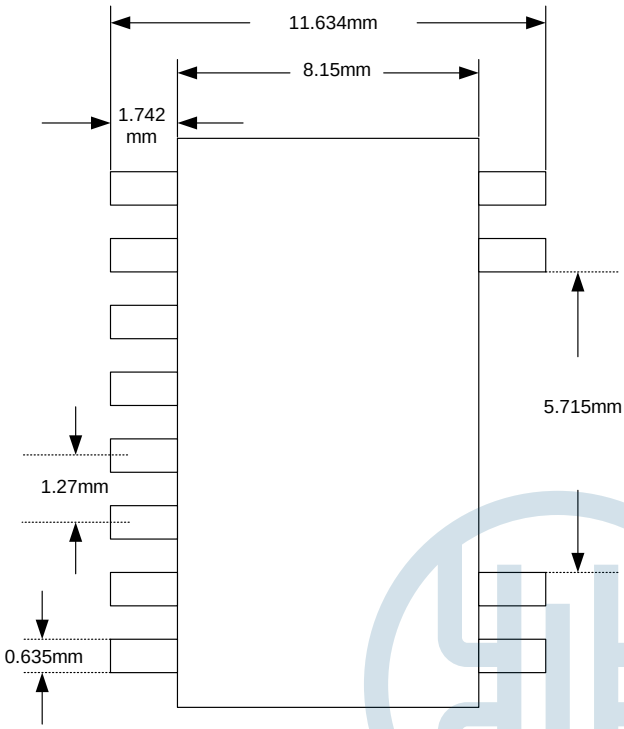


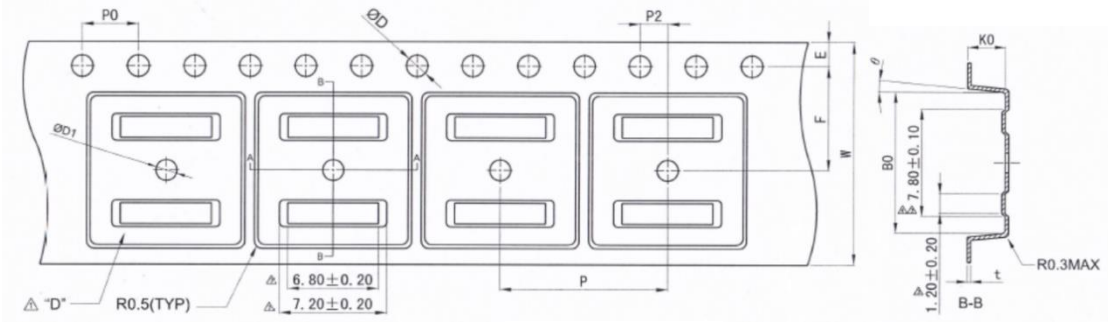
Fig 21. Outline Package

1. Top Marking

Fig 22.Top Marking

Line 1	XXXXXXXX=Product name
Line 2	YY = Work Year WW = Work Week ZZ=Manufacturing code from assembly house
Line 3	XXXX, no special meaning

2. Reel Information



Items	Size(mm)
E	1.75±0.10
F	7.50±0.05
P2	2.00±0.05
D	1.55±0.05
D1	1.5±0.10
P0	4.00±0.10
10P0	40.00±0.20

Items	Size(mm)
W	16.00±0.30
P	12.00±0.10
A0	10.90±0.10
B0	10.80±0.10
K0	3.00±0.10
t	0.30±0.05
K1	2.70±0.10
θ	5° TYP

Fig 23.Reel Information

Note：The Pin 1 of the chip is in the quadrant Q1

3. Ordering Guide

Table 18.Ordering Guide

Model Name [1]	Temperature Range	Withstand Voltage Rating (kV rms)	Package	MSL Peak Temp [2]	Quantity per reel
Pai8558EQ - W2R	−40~125°C	5.0	WB SOIC-12	Level-2-260C-1Year	1500

[1.]Paixxxxxx is equals to πxxxxxx in the customer BOM

[2.]MSL, Peak Temp.- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

4. Important Notice And Disclaimer

2Pai semi intends to provide customers with the latest, accurate, and in-depth documentation. However, no responsibility is assumed by 2Pai semi for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Characterization data, available modules, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only.2Pai semi reserves the right to make changes without further notice and limitation to product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information.2Pai semi shall have no liability for the consequences of use of the information supplied herein.

Trademarks and registered trademarks are the property of their respective owners. This document does not imply, or express copyright licenses granted hereunder to design or fabricate any integrated circuits.

Room 308-309, No.22, Boxia Road, Pudong New District, Shanghai, 201203, China 021-50850681

http://www.rpsemi.com/

5. Revision History

Ver	Date	Page	Change Record
0.1	2021-03-18	All	Initial version
0.2	2022-11-04	Page1，page5，page6，page7，page8，page10	Delete Truth Table in page1，add curves in page5，page6，add package dimension in page10，change figures in page1，7，and8，initial release