MPCS-5214 Series

SOP16, 4A Output Smart Gate Driver Optocoupler

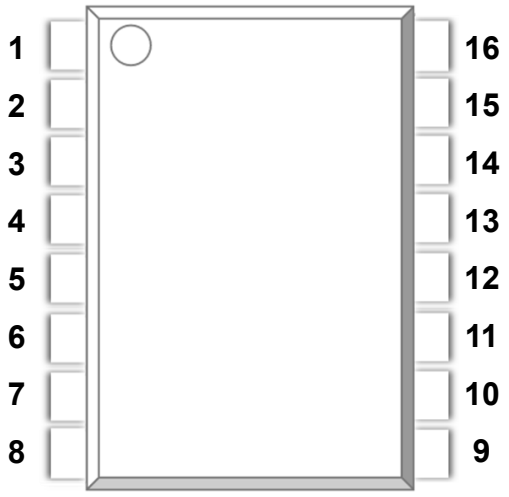
Description

The MPCS-5214 is an advanced 4 A output current, easyto-use, intelligent gate driver which makes IGBT V_{CE} fault protection compact, affordable, and easy-to implement. Features such as integrated V_{CE} detection, under voltage lockout (UVLO), “soft” IGBT turn-off, isolated open collector fault feedback and active Miller clamping provide maximum design flexibility and circuit protection. The MPCS-5214 contains a LED. The LED is optically coupled to an integrated circuit with a power output stage. MPCS-5214 is ideally suited for driving power IGBTs and MOSFETs used in motor control inverter applications. The voltage and current supplied by these optocouplers make them ideally suited for directly driving IGBTs with ratings up to 1200 V and 100 A. For IGBTs with higher ratings, the MPCS-5214 can be used to drive a discrete power stage which drives the IGBT gate. The MPCS-5214 has an insulation voltage of V_{IORM} = 1414 V_{PEAK}.

Features

- 4 A maximum peak output current
- 250 ns maximum propagation delay over temperature range
- 1.7A Active Miller Clamp. Clamp pin short to V_{EE} if not in used
- Miller Clamping
- Desaturation Detection
- Under Voltage Lock-Out Protection (UVLO) with Hysteresis
- “Soft” IGBT Turn-off

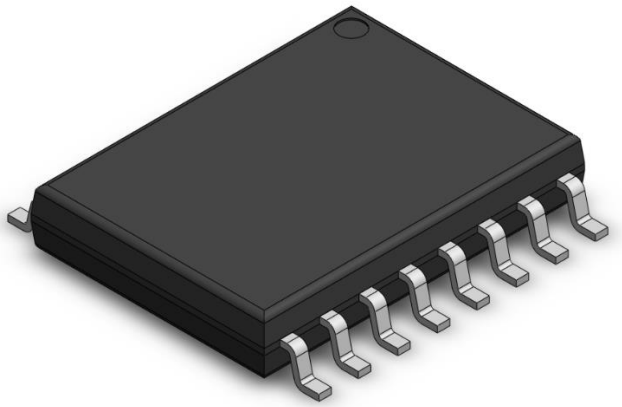
SCHEMATIC



PIN DEFINITION

1.V_S	16.V_E
2.V_{CC1}	15.V_{LED}
3.FAULT	14.DESAT
4.V_S	13.V_{CC2}
5.CATHODE	12.V_{EE}
6.ANODE	11.V_{OUT}
7.ANODE	10.V_{CLAMP}
8.CATHODE	9.V_{EE}

PACKAGE OUTLINE

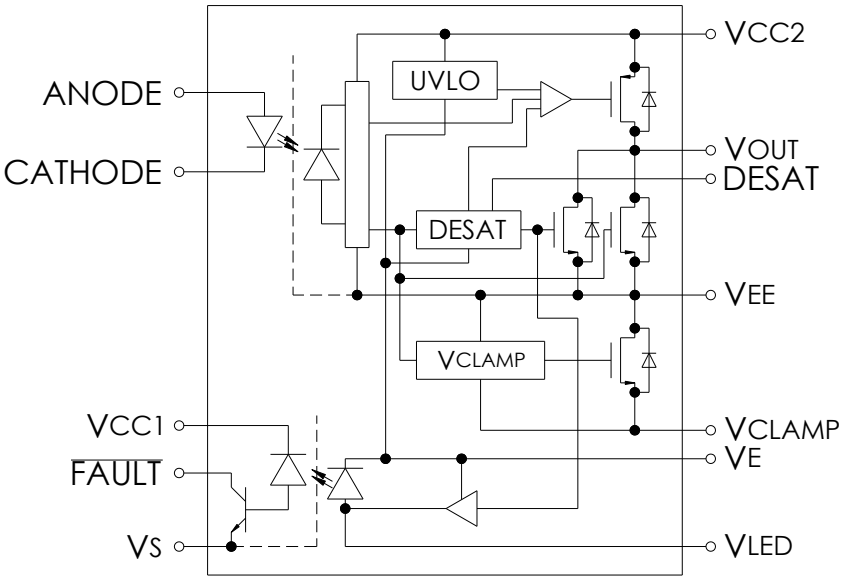


- Fault Reset by next LED turn-on (low to high) after fault mute period
- Available in SO-16 package
- 100 ns maximum pulse width distortion (PWD)
- 50 kV/μs minimum common mode rejection (CMR) at V_{CM} = 1500 V
- I_{CC}(max) < 5 mA maximum supply current
- Wide V_{CC} operating range: 15 V to 30 V over temperature range
- Wide operating temperature range: –40°C to 110°C
- Regulatory Approvals
  - UL - UL1577
  - VDE - EN60747-5-5(VDE0884-5)
  - CQC – GB4943.1, GB8898

Applications

- Isolated IGBT/Power MOSFET gate drive
- AC and brushless DC motor drives
- Industrial inverters and Uninterruptible Power Supply(UPS)

Internal Circuit



ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage Temperature	T_{stg}	-55	125	°C	
Operating Temperature	T_A	-40	110	°C	2
Output IC Junction Temperature	T_J	-	125	°C	2
Average Forward Input Current	I_F	-	20	mA	1
Peak Transient Input Current (<1 μs pulse width, 300pps)	$I_{F(TRAN)}$	-	1.0	A	
Reverse Input Voltage	V_R	-	5	V	
"High" Peak Output Current	$I_{OH(PEAK)}$	-	4.0	A	3
"Low" Peak Output Current	$I_{OL(PEAK)}$	-	4.0	A	3
Positive Input Supply Voltage	V_{CC1}	-0.5	7.0	V	
FAULT Output Current	I_{FAULT}	-	8.0	mA	
FAULT Pin Voltage	V_{FAULT}	-0.5	V_{CC1}	V	
Total Output Supply Volta	(V_{CC2} - V_{EE})	-0.5	33	V	
Negative Output Supply Voltage	(V_E - V_{EE})	-0.5	15	V	6
Positive Output Supply Voltage	(V_{CC2} - V_E)	-0.5	33-(V_E-V_{EE})	V	
Gate Drive Output Voltage	$V_{O(PEAK)}$	-0.5	V_{CC2}	V	
Peak Clamping Sinking Current	I_{Clamp}	-	1.7	A	
Miller Clamping Pin Voltage	V_{Clamp}	-0.5	V_{CC2}	V	
DESAT Voltage	V_{DESAT}	V_E	V_E+10	V	
Output IC Power Dissipation	P_O	-	600	mW	2
Input IC Power Dissipation	P_I	-	150	mW	2
Solder Reflow Temperature Profile	See Package Outline Drawings section				

RECOMMENDED OPERATION CONDITIONS

PARAMETER	SYMBOL	MIN.	MAX.	UNIT	Note
Operating Temperature	T_A	-40	110	°C	2
Total Output Supply Voltage	(V_{CC2} - V_{EE})	15	30	V	7
Negative Output Supply Voltage	(V_E - V_{EE})	0	15	V	4
Positive Output Supply Voltage	(V_{CC2} - V_E)	15	30-(V_E-V_{EE})	V	
Input Current (ON)	$I_{F(ON)}$	8	12	mA	
Input Voltage (OFF)	$V_{F(OFF)}$	-3.6	0.8	V	

ELECTRICAL OPTICAL CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	NOTE
INPUT CHARACTERISTICS							
FAULT Logic Low Output Voltage	V_{FAULTL}	-	0.01	0.4	V	I_{FAULT} = 1.1 mA, V_{CC1} = 5.5V	
		-	0.02	0.4	V	I_{FAULT} = 1.1 mA, V_{CC1} = 3.3V	
FAULT Logic High Output Current	I_{FAULTH}	-	0.01	0.5	μA	V_{FAULT} = 5.5 V, V_{CC1} = 5.5V	
		-	0.006	0.3	μA	V_{FAULT} = 3.3 V, V_{CC1} = 3.3V	
High Level Output Current	I_{OH}	-	-2.9	-1.2	A	$V_O = V_{CC2} – 4$	5
		-	-	-4.0	A	$V_O = V_{CC2} – 15$	3
Low Level Output Current	I_{OL}	1.2	3.1	-	A	$V_O = V_{EE} + 2.5$	5
		4.0	-	-	A	$V_O = V_{EE} + 15$	3
Low Level Output Current During Fault Condition	I_{OLF}	70	100	230	mA	V_{OUT} - V_{EE} = 14 V	6
High Level Output Voltage	V_{OH}	V_{CC}-0.5	V_{CC}-0.1	-	V	I_O = -650 μA	7,8,9,23
Low Level Output Voltage	V_{OL}	-	0.1	0.5	V	I_O = 100 mA	
Clamp Pin Threshold Voltage	V_{tClamp}	-	2.2	-	V	-	
Clamp Low Level Sinking Current	I_{CL}	0.5	1.5	-	A	$V_O = V_{EE} + 2.5$	
High Level Supply Current	I_{CC2H}	-	2.23	5	mA	I_O = 0 mA	9
Low Level Supply Current	I_{CC2L}	-	2.36	5	mA	I_O = 0 mA	
Blanking Capacitor Charging Current	I_{CHG}	0.13	-0.24	-0.33	mA	V_{DESAT} = 2 V	9,10
Blanking Capacitor Discharge Current	I_{DSCHG}	10	31	-	mA	V_{DESAT} = 7.0 V	
DESAT Threshold	V_{DESAT}	6	6.7	7.5	V	V_{CC2} -V_E >V_{UVLO-}	9
UVLO Threshold	V_{UVLO+}	10.5	11.5	13.5	V	V_O > 5 V	7,9,11
	V_{UVLO-}	9.2	10.5	11.1	V	V_O < 5 V	7,9,12
UVLO Hysteresis	(V_{UVLO+} - V_{UVLO-})	0.4	1.0	-	V	-	
Threshold Input Current Low to High	I_{FLH}	-	0.27	5	mA	I_O = 0 mA, V_O > 5 V	
Threshold Input Voltage High to Low	V_{FHL}	0.8	1.74	-	V	-	
Input Forward Voltage	V_F	1.6	2.0	2.4	V	IF = 10 mA	
Input Reverse Breakdown Voltage	BV_R	5	-	-	V	IR = 10 μA	
Input Capacitance	C_{IN}	-	70	-	pF	f = 1 MHz, VF = 0 V	

Unless otherwise noted, all typical values at T_A = 25°C, V_{CC2} - V_{EE} = 30 V, V_E - V_{EE} = 0 V;
all Minimum/Maximum specifications are at Recommended Operating Conditions.

SWITCHING SPECIFICATION

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	NOTE
Propagation Delay Time to Output Low Level	t_{PHL}	50	94	250	ns	Rg = 10 Ω, Cg = 10 nF, f = 10 kHz, Duty Cycle = 50%, I_F = 10 mA, V_{CC2} = 30 V	
Propagation Delay Time to Output High Level	t_{PLH}	50	97	250	ns		13,15
Pulse Width Distortion	PWD	-100	-	100	ns		14,17
Propagation Delay Difference Between Any Two Parts	PDD (t_{PHL} - t_{PLH})	-150	-	150	ns		17,16
Rise Time	t_r	-	22	-	ns		
Fall Time	t_f	-	14	-	ns		
DESAT Sense to 90% VO Delay	$t_{DESAT(90\%)}$	-	0.1	0.5	μs	C_{DESAT} = 100pF, R_F=2.1kΩ, Rg = 10 Ω, Cg = 10 nF, V_{CC2} = 30 V	19
DESAT Sense to 10% VO Delay	$t_{DESAT(10\%)}$	-	2.3	3	μs	C_{DESAT} = 100pF, R_F=2.1kΩ , Rg = 10 Ω, Cg = 10 nF, V_{CC2} = 30 V	
DESAT Sense to Low Level FAULT Signal Delay	$t_{DESAT(FAULT)}$	-	0.2	0.5	μs	C_{DESAT} = 100 pF, R_F = 2.1kΩ, C_F = Open, Rg = 10 Ω, Cg = 10 nF, V_{CC2} = 30 V	18
		-	0.8	-	μs	C_{DESAT} = 100 pF, R_F = 2.1kΩ, C_F = 1 nF, Rg = 10 Ω, Cg = 10 nF, V_{CC2} = 30 V	
DESAT Sense to DESAT Low Propagation Delay	$t_{DESAT(LOW)}$	-	0.15	-	μs	C_{DESAT} = 100pF, R_F = 2.1kΩ, Rg = 10 Ω, Cg = 10 nF, V_{CC2} = 30 V	19
DESAT Input Mute	$t_{DESAT(MUTE)}$	5	-	-	μs	C_{DESAT} = 100pF, R_F = 2.1kΩ, Rg = 10 Ω, Cg = 10 nF, V_{CC1} = 5.5V, V_{CC2} = 30 V	20
RESET to High Level FAULT Signal Delay	$t_{RESET(FAULT)}$	0.2	0.6	2.0	μs	C_{DESAT} = 100pF, RF = 2.1 kΩ, Rg = 10 Ω, Cg = 10 nF, V_{CC1} = 5.5V, V_{CC2} = 30 V	
RESET to High Level FAULT Signal Delay	$t_{RESET(FAULT)}$	0.2	0.6	2.5	μs	C_{DESAT} = 100pF, RF = 2.1 kΩ, Rg = 10 Ω, Cg = 10 nF, V_{CC1} = 3.3V, V_{CC2} = 30 V	

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	NOTE
Output High Level Common Mode Transient Immunity	|CMH|	15	-	-	kV/μs	T_A=25°C, I_F=10mA ,V_{CM}=1500 V, V_{CC2}=30V, R_F=2.1kΩ, C_F=15 pF	21
		50	-	-		A=25°C, I_F=10mA ,V_{CM}=1500 V, V_{CC2}=30V, R_F=2.1kΩ, C_F=1nF	21,26
Output Low Level Common Mode Transient Immunity	|CML|	15	-	-	kV/μs	T_A=25°C, V_F=0V, V_{CM}=1500V, V_{CC2}=30V, R_F=2.1kΩ, C_F=15 pF	22
		50	-	-		T_A=25°C, V_F=0V, V_{CM}=1500V, V_{CC2}=30V, R_F=2.1kΩ, C_F=1nF	

Unless otherwise noted, all typical values at T_A = 25°C, V_{CC2} - V_{EE} = 30 V, V_E - V_{EE} = 0 V; all Minimum/Maximum specifications are at Recommended Operating Conditions.

ISOLATION CHARACTERISTIC

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION	NOTE
Withstand Insulation Test Voltage	V_{ISO}	5000	-	-	V	RH ≤ 40%-60%, t = 1min, T_A = 25 °C	24,25
Input-Output Resistance	R_{I-O}	-	10^{12}	-	Ω	V_{I-O} = 500V DC	25

Note1: Derate linearly above 70°C free air temperature at a rate of 0.3 mA/°C.

Note2: In order to achieve the absolute maximum power dissipation specified, pins 4, 9, and 10 require ground plane connections and may require airflow. See the Thermal Model section in the application notes at the end of this data sheet for details on how to estimate junction temperature and power dissipation. In most cases the absolute maximum output IC junction temperature is the limiting factor. The actual power dissipation achievable will depend on the application environment (PCB Layout, air flow, part placement, etc.). See the Recommended PCB Layout section in the application notes for layout considerations. Output IC power dissipation is derated linearly at 10 mW/°C above 90°C. Input IC power dissipation does not require derating.

Note3: Maximum pulse width = 10 μs. This value is intended to allow for component tolerances for designs with IO peak minimum = 1.0 A. Derate linearly from 2.0 A at +25°C to 1.5 A at +105°C. This compensates for increased I_{OPEAK} due to changes in V_{OL} over temperature.

Note4: This supply is optional. Required only when negative gate drive is implemented.

Note5: Maximum pulse width = 50 μs.

Note6: See the Slow IGBT Gate Discharge During Fault Condition section in the applications notes at the end of this data sheet for further details.

Note7: 15 V is the recommended minimum operating positive supply voltage (V_{CC2} - V_E) to ensure adequate margin in excess of the maximum V_{UVLO+} threshold of 12.5 V. For High Level Output Voltage testing, V_{OH} is measured with a dc load current. When driving capacitive loads, V_{OH} will approach V_{CC} as I_{OH} approaches zero units.

Note8: Maximum pulse width = 1.0 ms.

Note9: Once V_O of the MPCS-5214 is allowed to go high (V_{CC2} - V_E > V_{UVLO+}), the DESAT detection feature of the MPCS-5214 will be the primary source of IGBT protection. U_{VLO} is needed to ensure DESAT is functional. Once V_{CC2} is increased from 0V to above V_{UVLO+}, DESAT will remain functional until V_{CC2} is decreased below V_{UVLO-}. Thus, the DESAT detection and U_{VLO} features of the MPCS-5214 work in conjunction to ensure constant IGBT protection.

Note10: See the DESAT fault detection blanking time section in the applications notes at the end of this data sheet for further details.

Note11: This is the “increasing” (i.e. turn-on or “positive going” direction) of V_{CC2} - V_E

Note12: This is the “decreasing” (i.e. turn-off or “negative going” direction) of V_{CC2} - V_E

Note13: This load condition approximates the gate load of a 1200 V/75A IGBT.

Note14: Pulse Width Distortion (PWD) is defined as $|t_{PHL} - t_{PLH}|$ for any given unit.

Note15: As measured from I_F to V_O.

Note16: The difference between t_{PHL} and t_{PLH} between any two MPCS-5214 parts under the same test conditions.

Note17: As measured from ANODE, CATHODE of LED to $V_{OUT.}$

Note18: This is the amount of time from when the DESAT threshold is exceeded, until the FAULT output goes low.

Note19: This is the amount of time the DESAT threshold must be exceeded before V_{OUT} begins to go low, and the FAULT output to go low. This is supply voltage dependent.

Note20: Auto Reset: This is the amount of time when V_{OUT} will be asserted low after DESAT threshold is exceeded. See the Description of Operation (Auto Reset) topic in the application information section.

Note21: Common mode transient immunity in the high state is the maximum tolerable dV_{CM}/dt of the common mode pulse, V_{CM}, to assure that the output will remain in the high state (i.e., V_O > 15 V or FAULT > 2 V).

Note22: Common mode transient immunity in the low state is the maximum tolerable dV_{CM}/dt of the common mode pulse, V_{CM}, to assure that the output will remain in a low state (i.e., V_O < 1.0 V or FAULT < 0.8 V).

Note23: To clamp the output voltage at V_{CC} - 3 V_{BE}, a pull-down resistor between the output and VEE is recommended to sink a static current of 650 μA while the output is high. See the Output Pull-Down Resistor section in the application notes at the end of this data sheet if an output pull-down resistor is not used.

Note24: In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage ≥ 6000 Vrms for 1 second. This test is performed before the 100% production test for partial discharge (method b) shown in IEC/EN/DIN EN 60747-5-5 Insulation Characteristic Table.

Note25: This is a two-terminal measurement: pins 1-8 are shorted together and pins 9-16 are shorted together.

Note26: Split resistors network with a ratio of 1:1 is needed at input LED1.

TYPICAL PERFORMANCE CURVES & TEST CIRCUITS

Fig.1 I_{OH} vs. Temperature

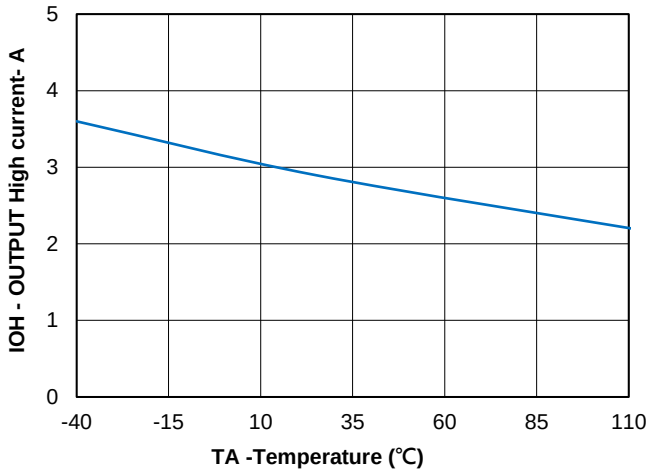


Fig.2 I_{OL} vs. Temperature

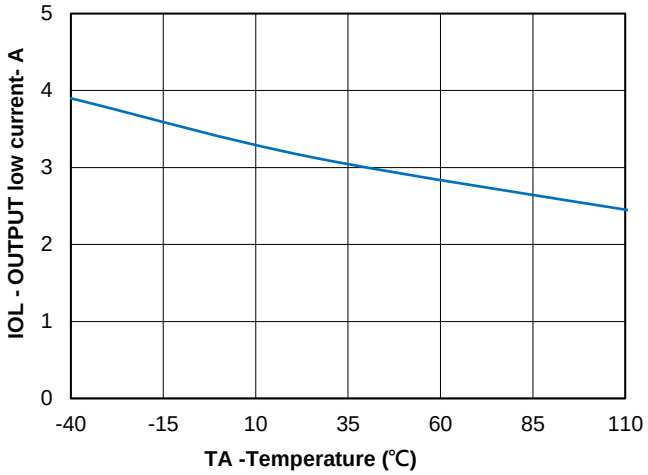


Fig.3 V_{OH} vs. Temperature

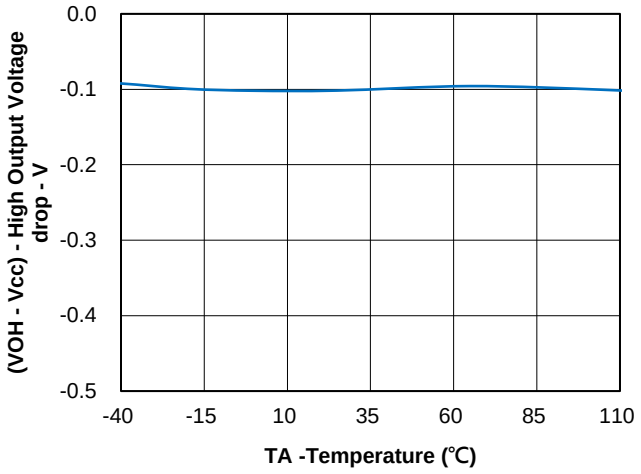


Fig.4 V_{OL} vs. Temperature

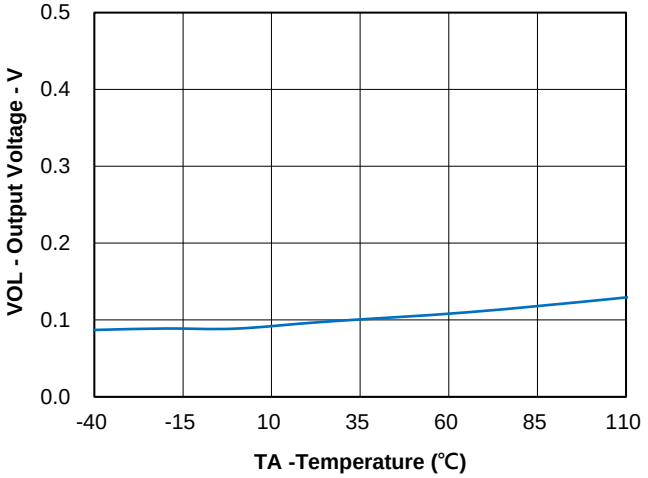


Fig.5 V_{OH} vs. I_{OH}

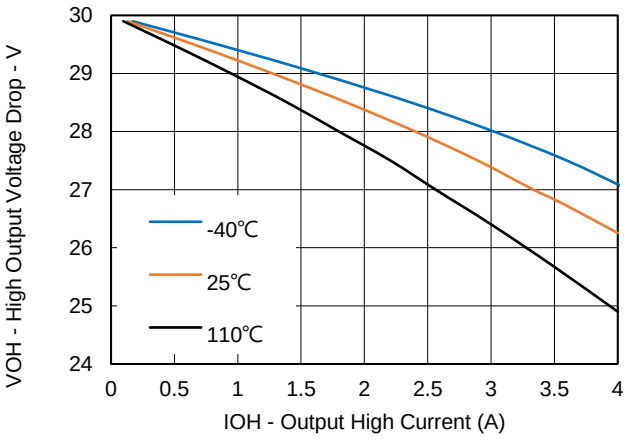


Fig.6 V_{OL} vs. I_{OL}

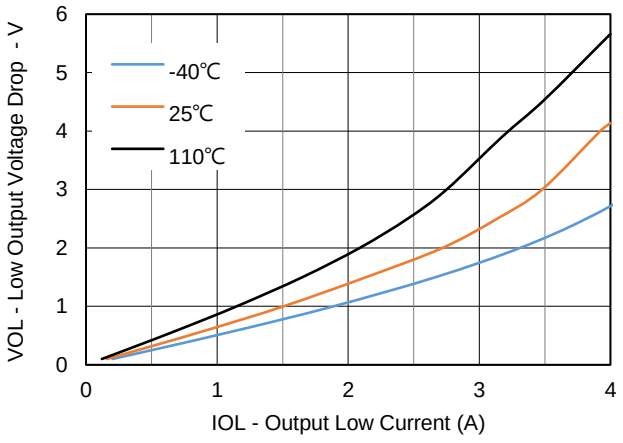


Fig.7 I_{CL} vs. Temperature

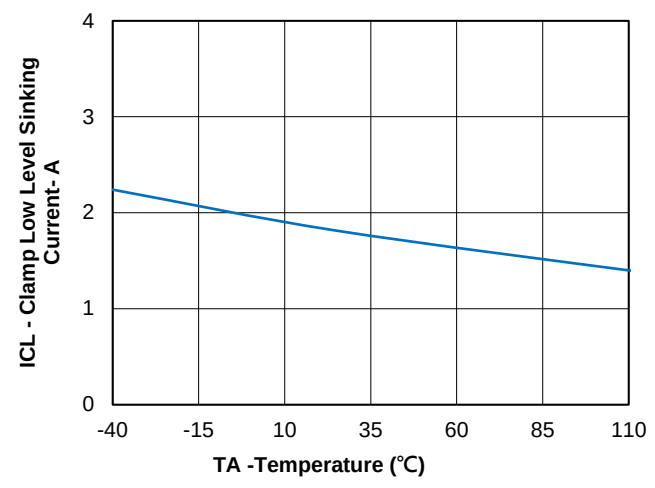


Fig.8 I_{CC2} vs. Temperature

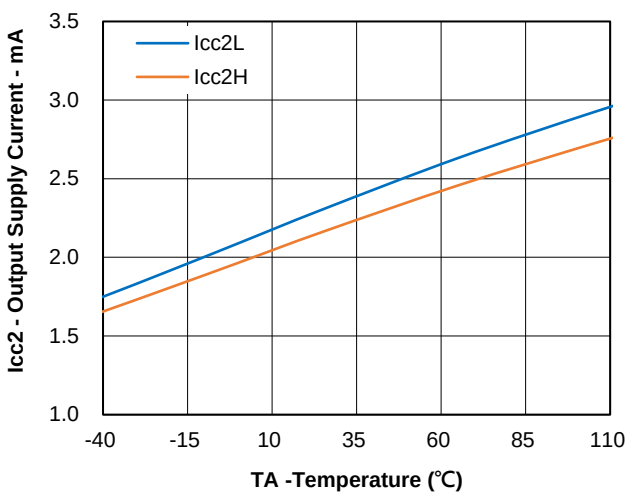


Fig.9 I_{CC2} vs. V_{CC2}

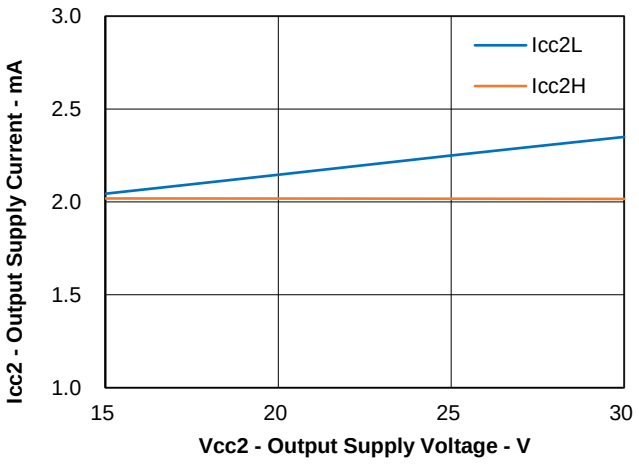


Fig.10 I_{CHG} vs. Temperature

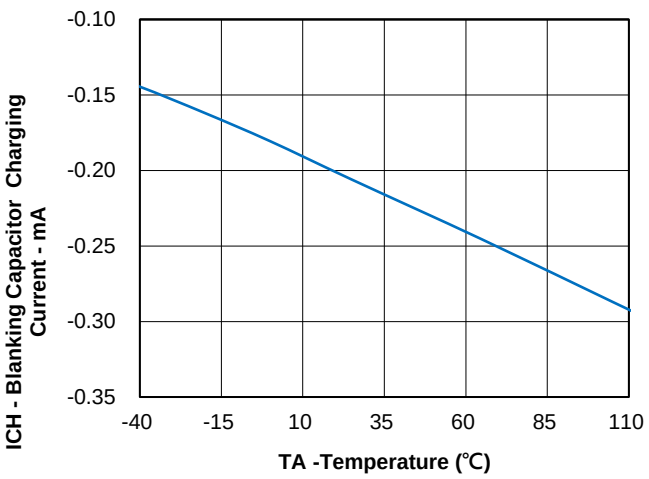


Fig.11 DESAT Threshold vs. Temperature

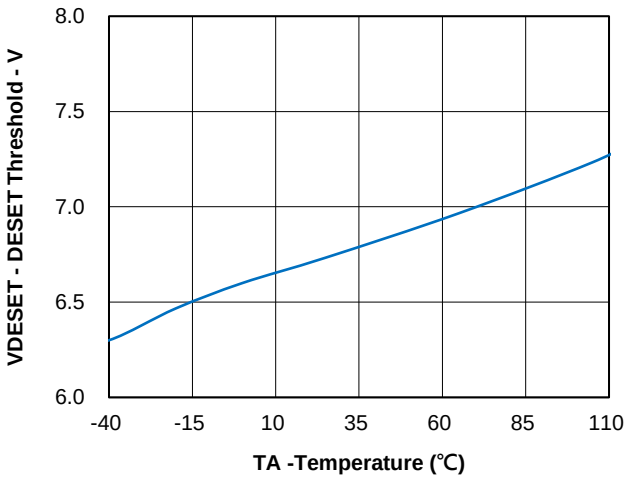


Fig.12 Propagation Delay vs. Temperature

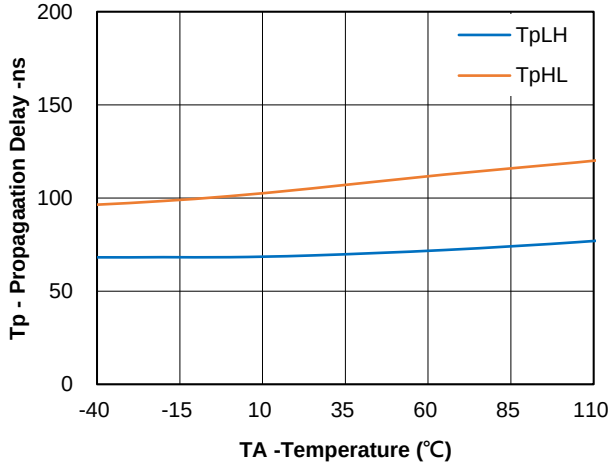


Fig.13 Propagation Delay vs. Supply Voltage

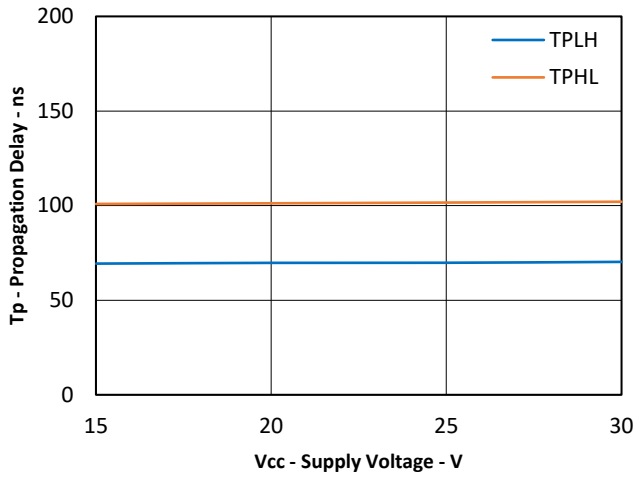


Fig.14 Propagation Delay vs. R_L

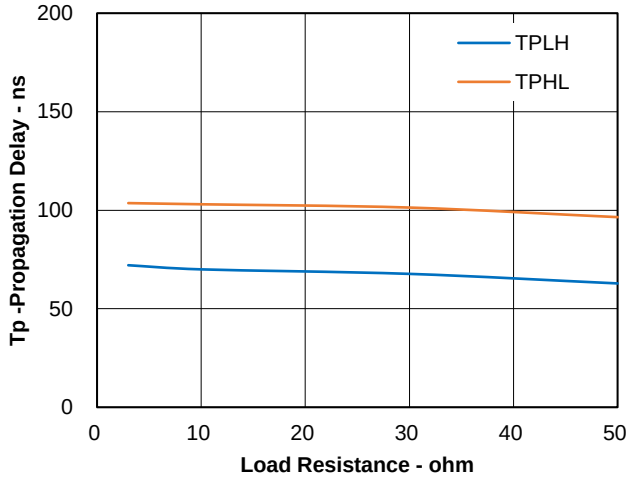


Fig.15 Propagation Delay vs. C_L

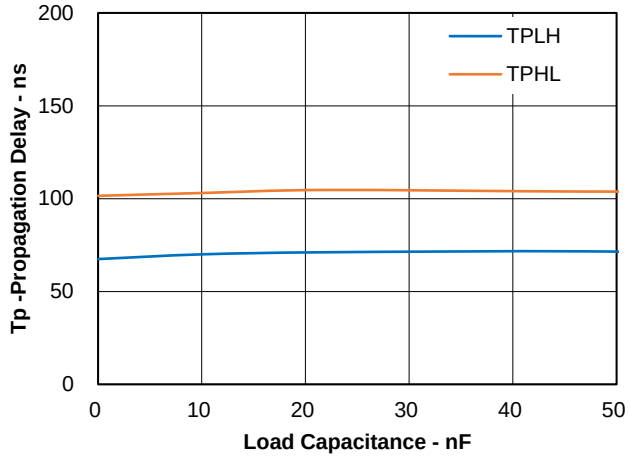


Fig.16 $T_{DESAT90\%}$ vs. Temperature

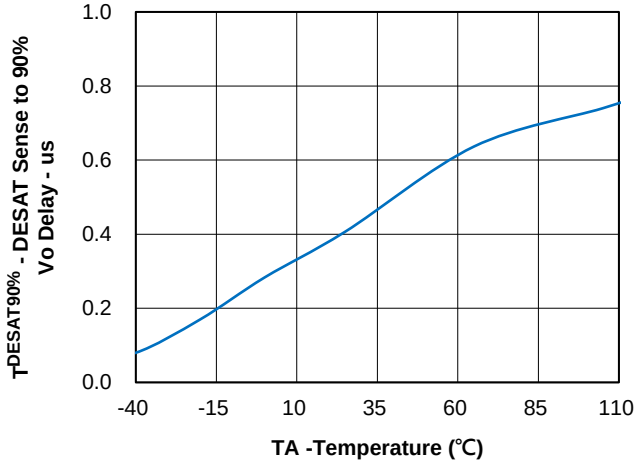


Fig.17 $T_{DESAT10\%}$ vs. Temperature

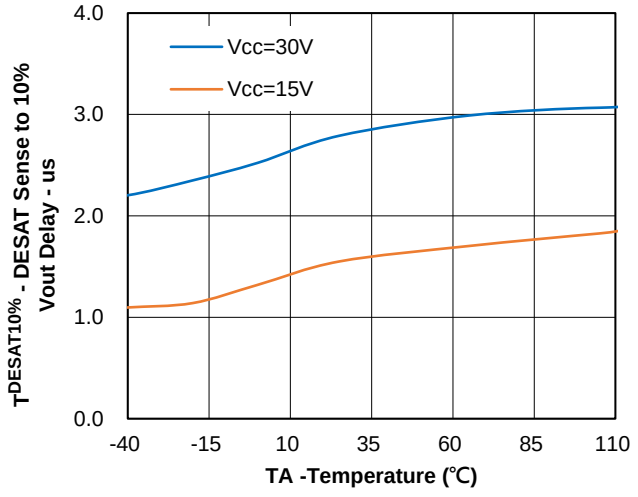


Fig.18 $T_{DESAT10\%}$ vs. R_L

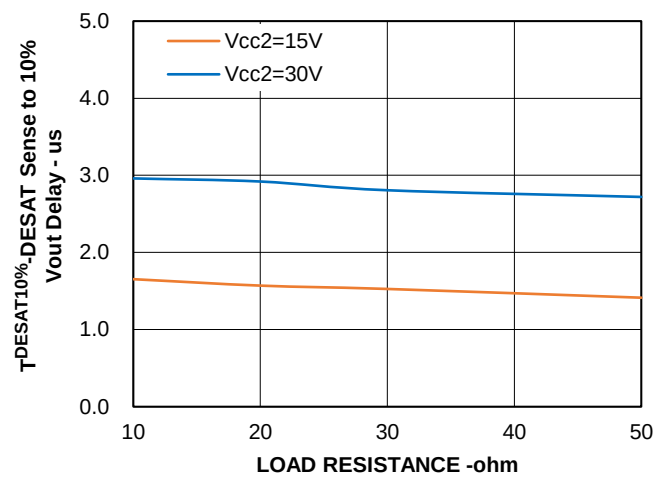


Fig.19 T_{DESAT} 10% vs. C_L

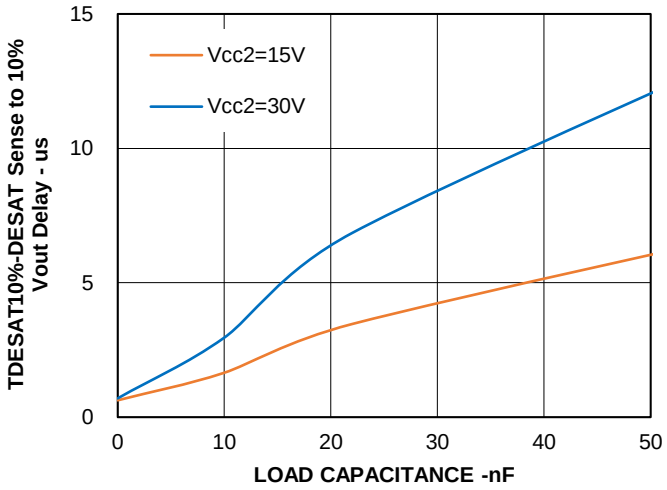


Fig.18 I_{OH} Pulsed Test Circuit

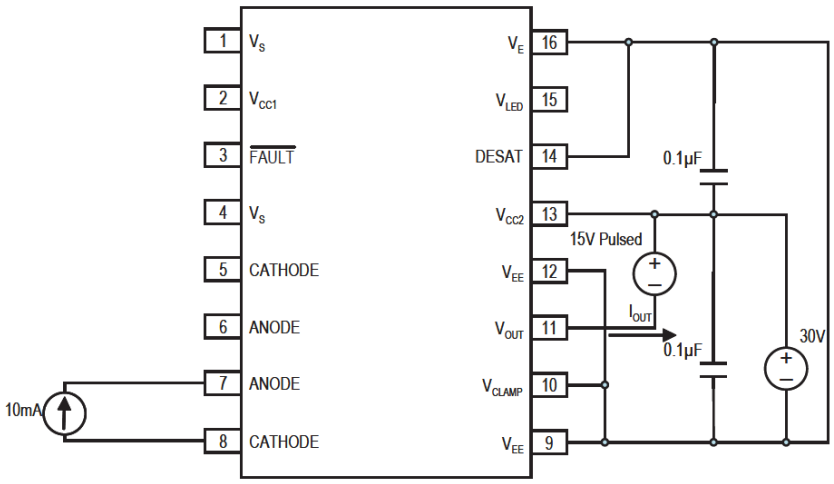


Fig.19 I_{OL} Pulsed Test Circuit

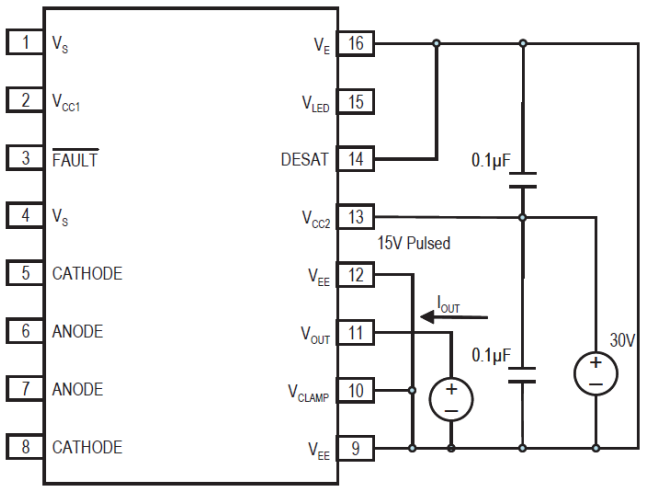


Fig.20 V_{OH} Pulsed Test Circuit

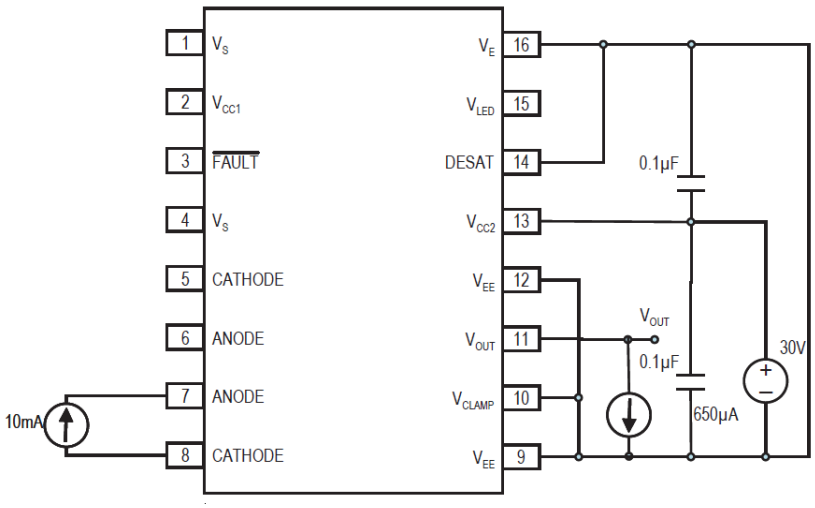


Fig.21 V_{OL} Pulsed Test Circuit

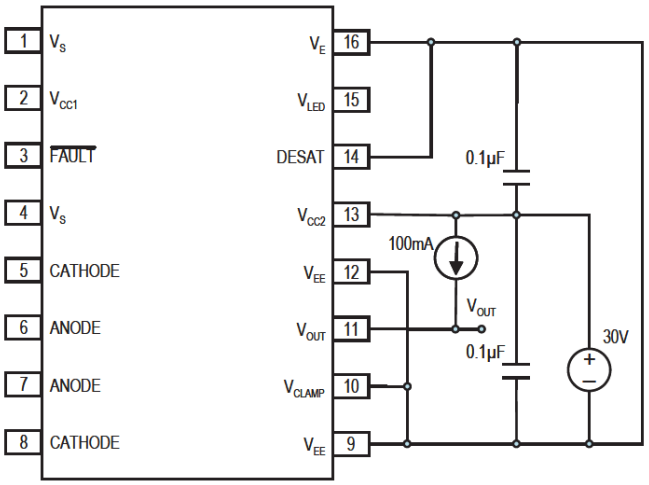


Fig.22 I_{CC2H} Test Circuit

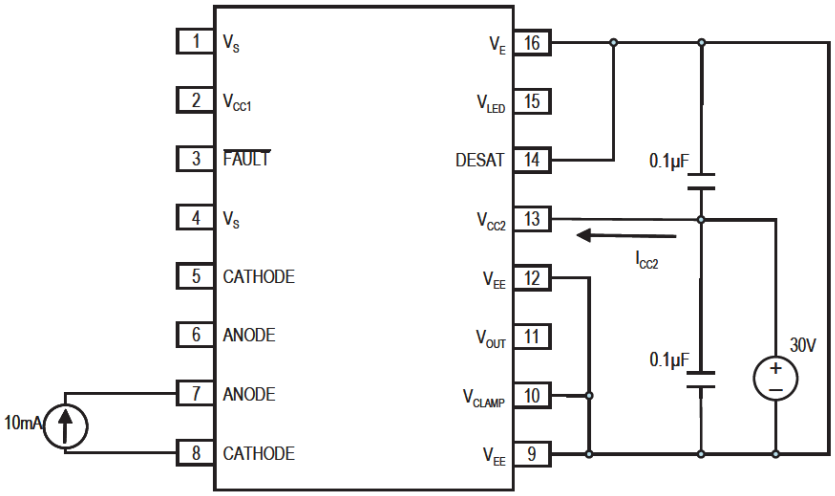


Fig.23 I_{CC2L} Test Circuit

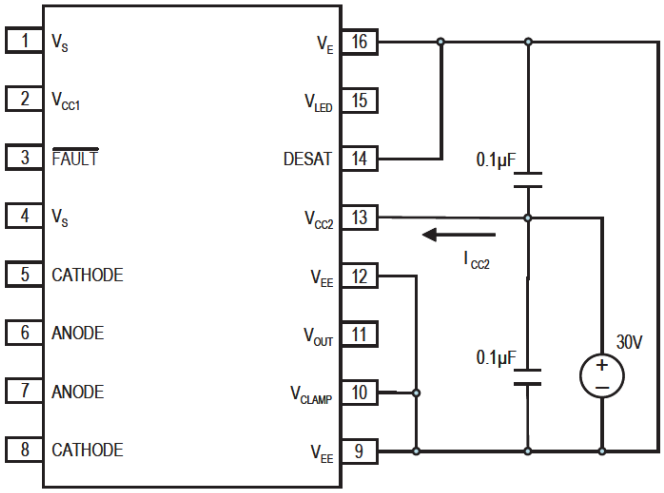


Fig.24 I_{CHG} Pulsed Test Circuit

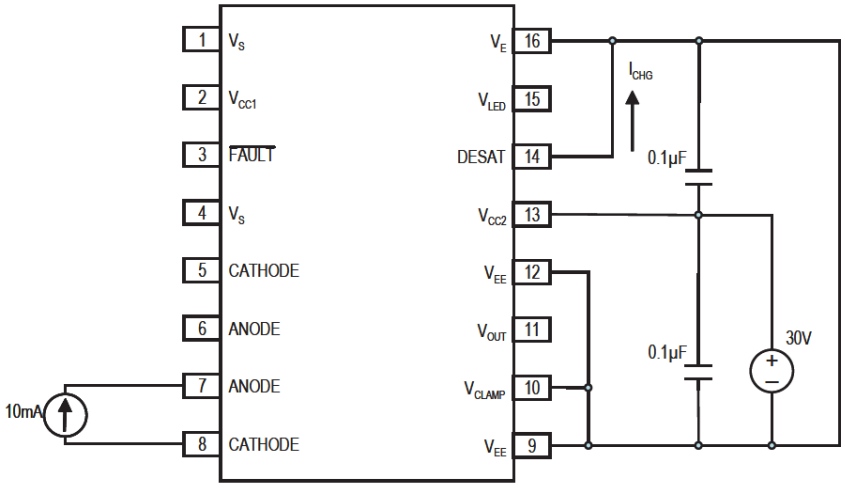


Fig.25 I_{DSCHG} Test Circuit

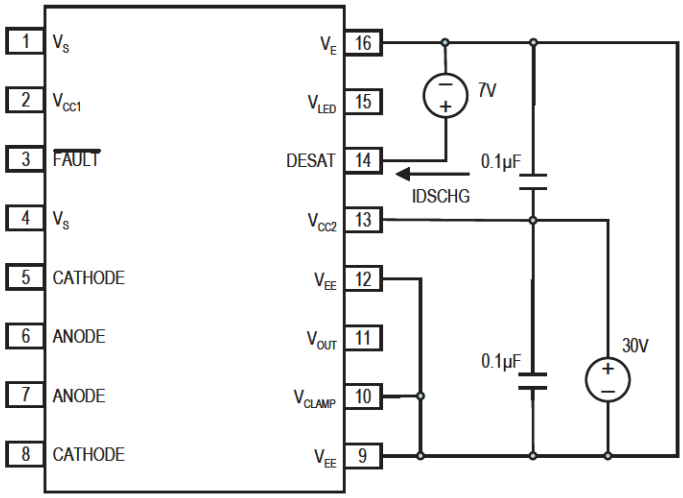
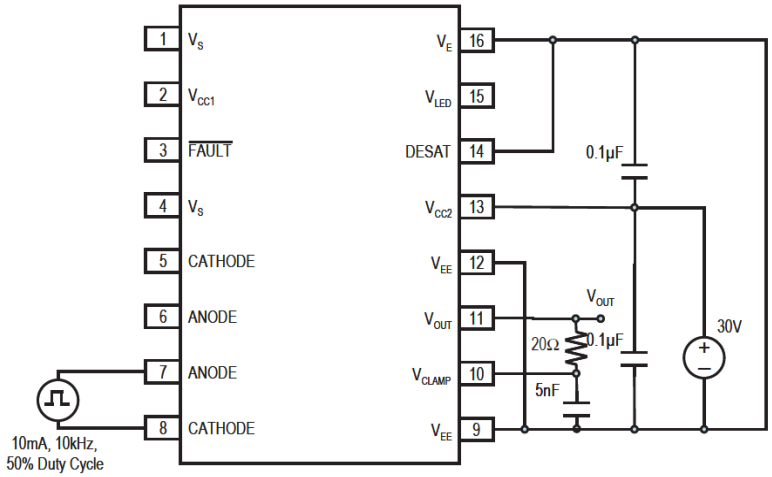


Fig.26 t_{PLH}, t_{PHL}, t_f, t_r, Test Circuit



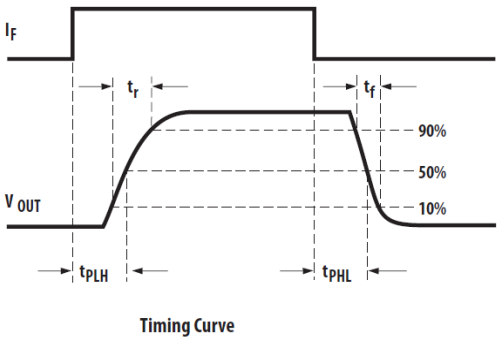
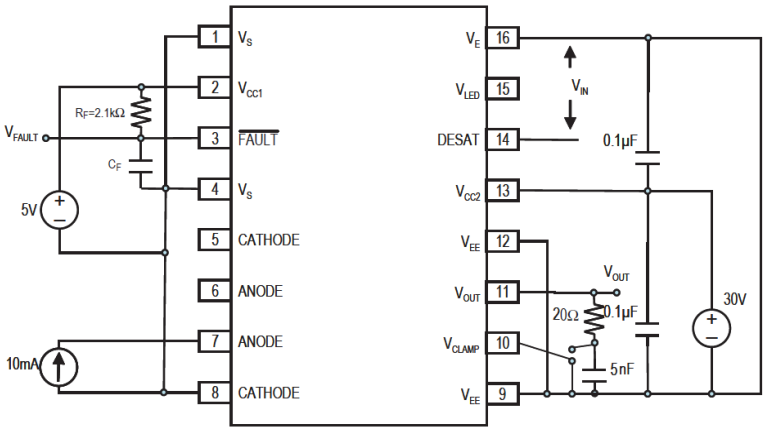
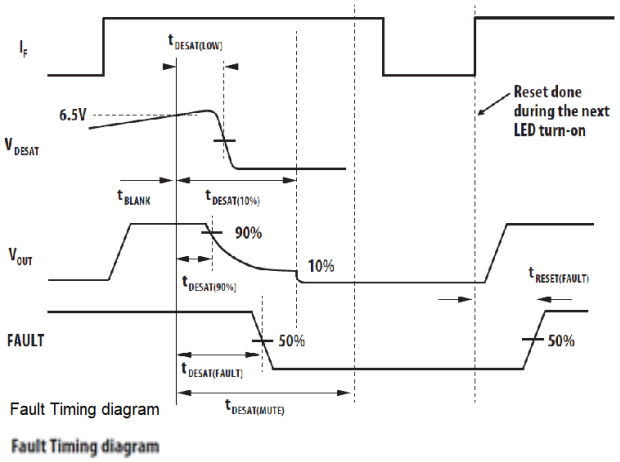


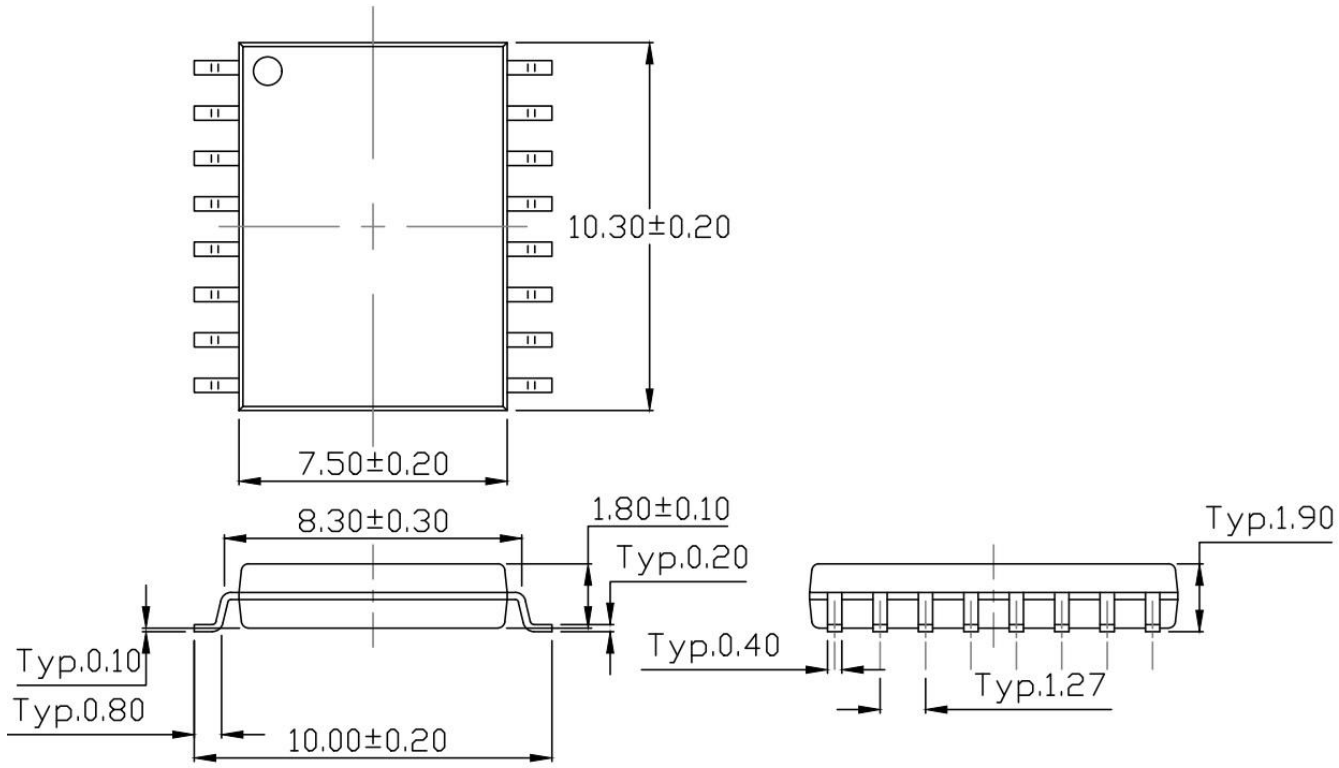
Fig.27 t_{DESAT} Fault Test Circuit





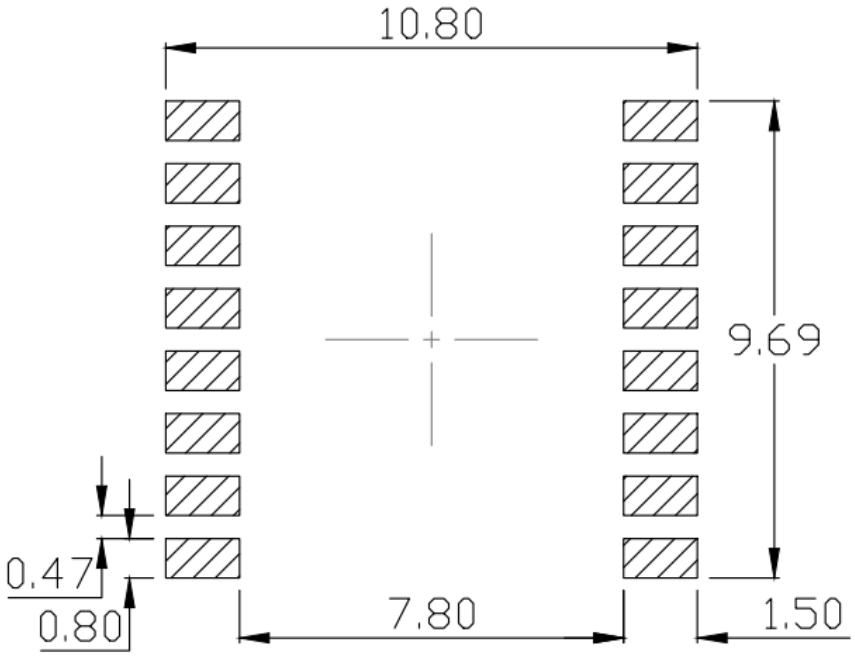
Fault Timing diagram

PACKAGE DIMENSIONS (Dimensions in mm unless otherwise stated)



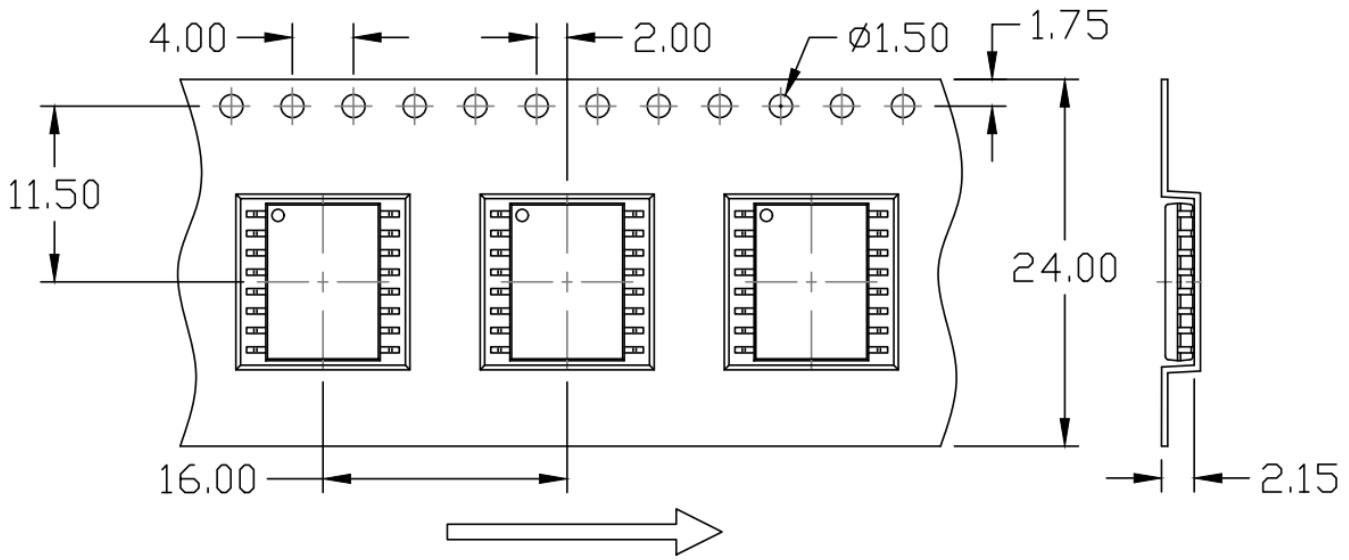
General Tolerance: +/-0.25mm

RECOMMENDED SOLDER MASK (Dimensions in mm unless otherwise stated)

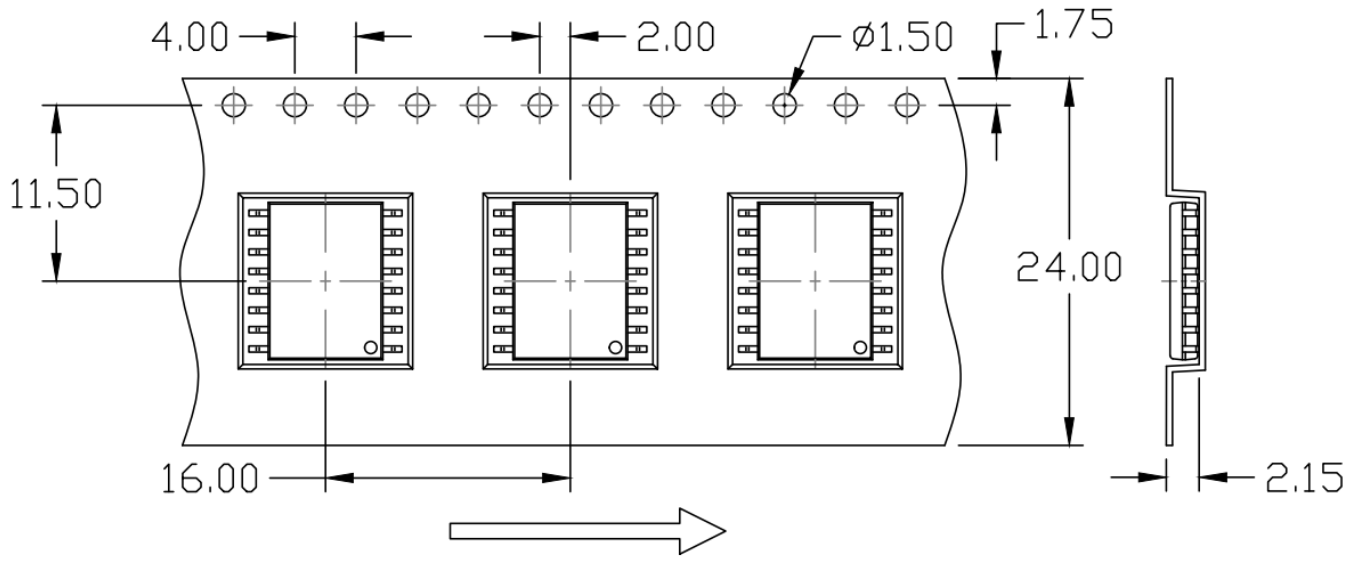


CARRIER TAPE SPECIFICATIONS (Dimensions in mm unless otherwise stated)

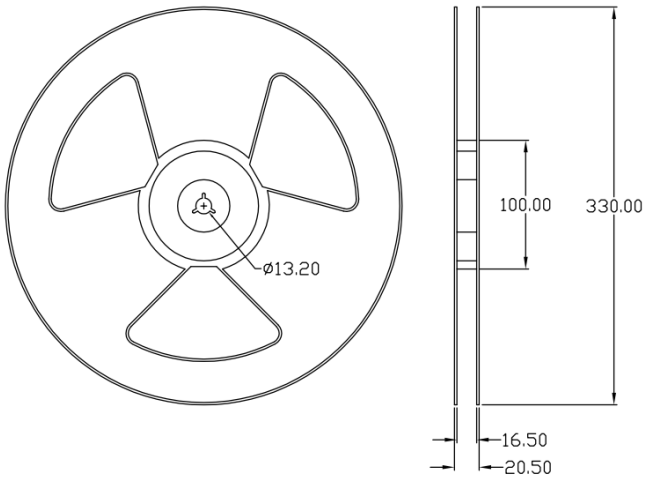
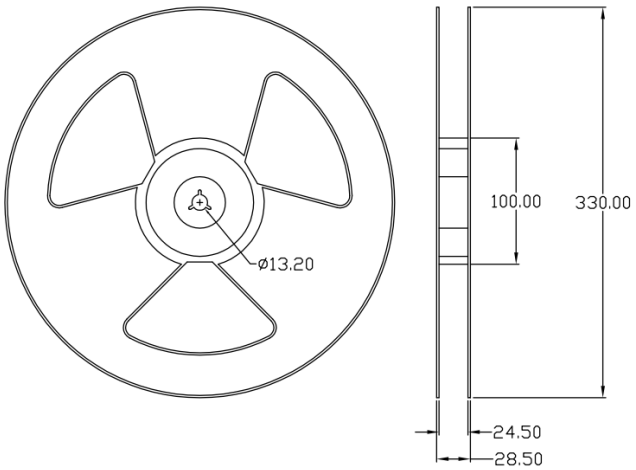
Option T1



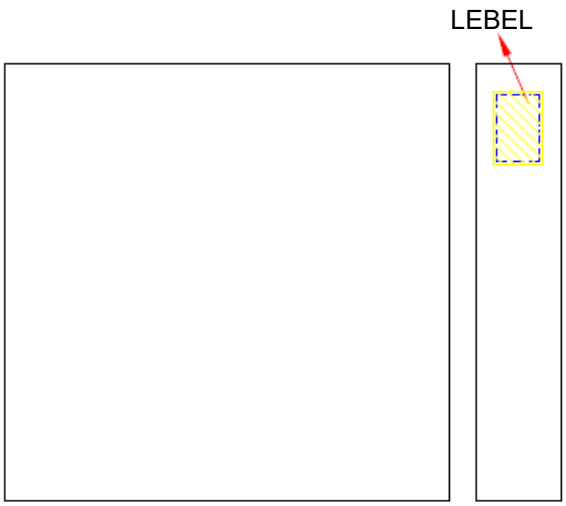
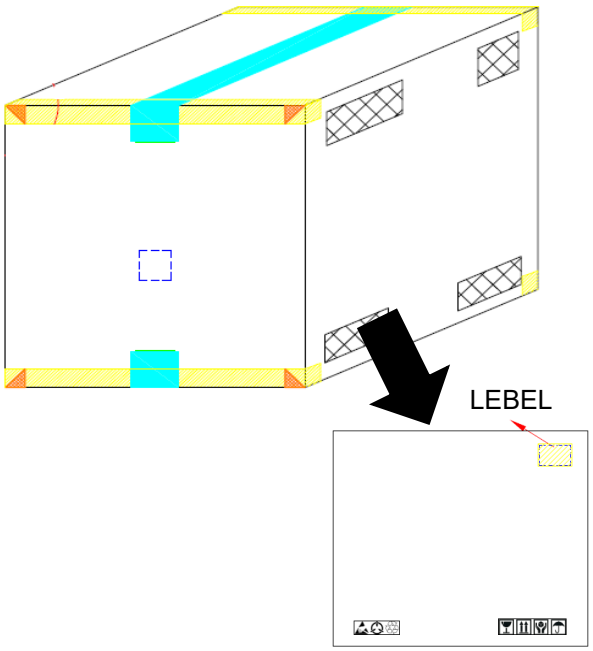
Option T2



REEL SPECIFICATIONS (Dimensions in mm unless otherwise stated)

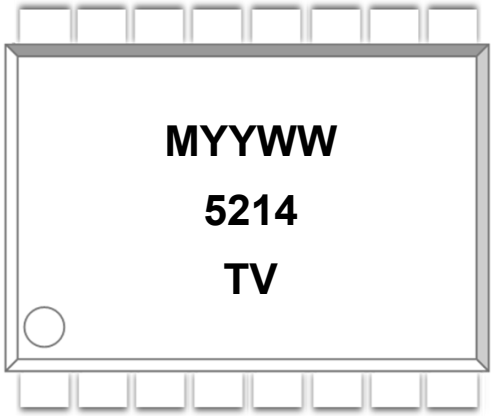
Surface Mount Lead Forming (P Type)	Surface Mount (Gullwing) Lead Forming (W Type)
	

BOX SPECIFICATIONS (Reel Type)

INNER BOX	OUTER BOX
	
L x W x H = 36cm x 36cm x 6.9cm	L x W x H = 45cm x 38cm x 38cm

ORDERING AND MARKING INFORMATION

MARKING INFORMATION



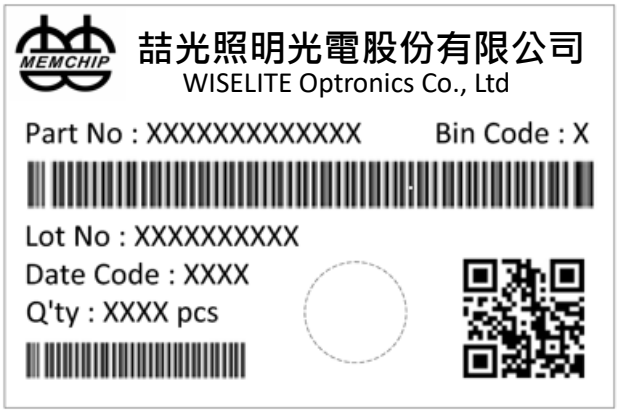
M : Company Abbr.
YY : Year date code
WW : 2-digit work week
5214 : Part Number
T or H : Factory identification mark
V : VDE Identification(Option)

ORDERING INFORMATION

MPCS-5214-ZV

MPC – Company Abbr.
S – Stack
5214 – Part Number
Z – Tape and Reel Option (T1/T2)
V –VDE Option (V or None)

LABEL INFORMATION

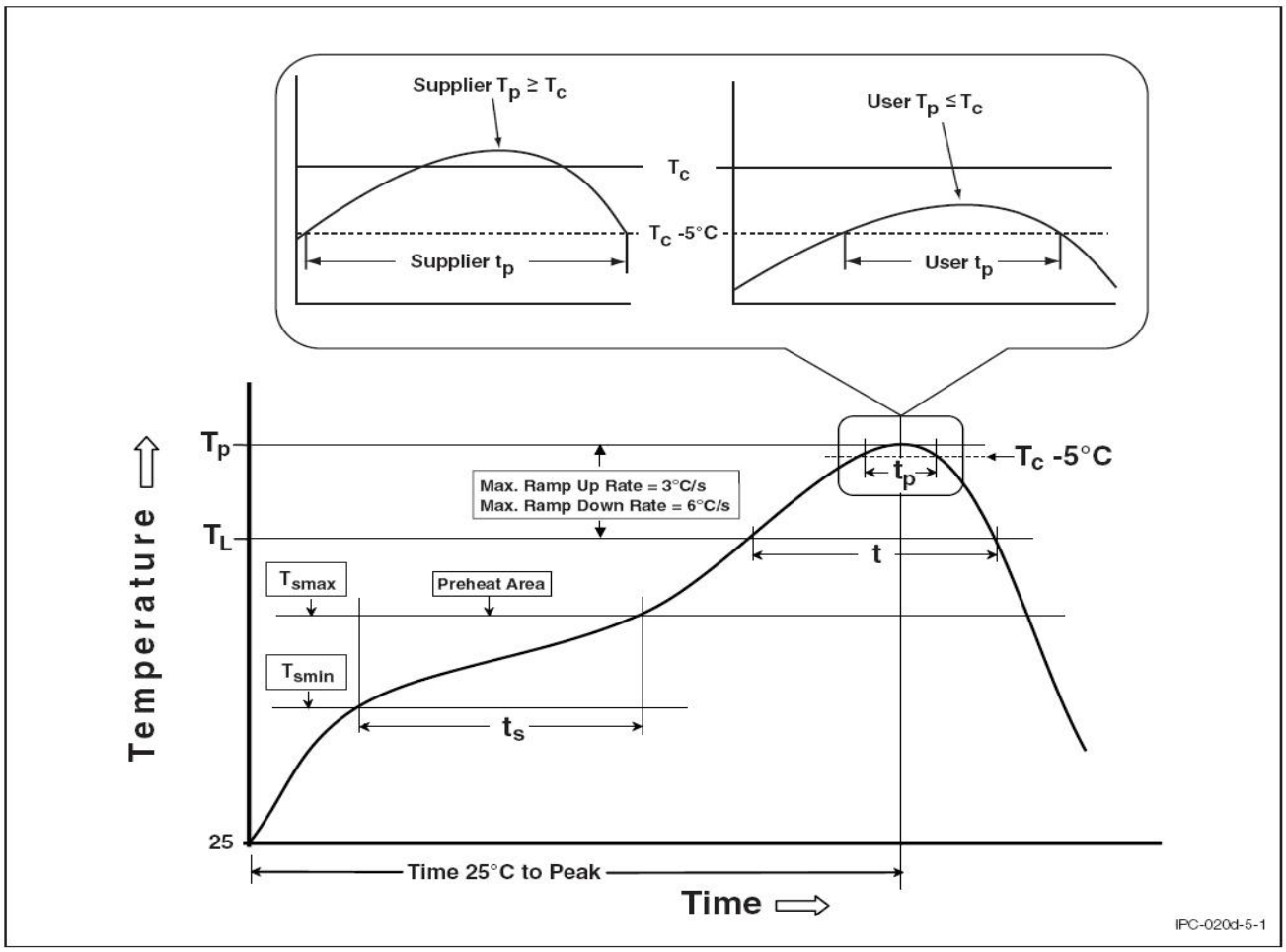


PACKING QUANTITY

Option	Quantity	Quantity – Inner box	Quantity – Outer box
T1/T2	1000 Units/Reel	2 Reels/Inner box	5 Inner box/Outer box = 10k Units

REFLOW INFORMATION

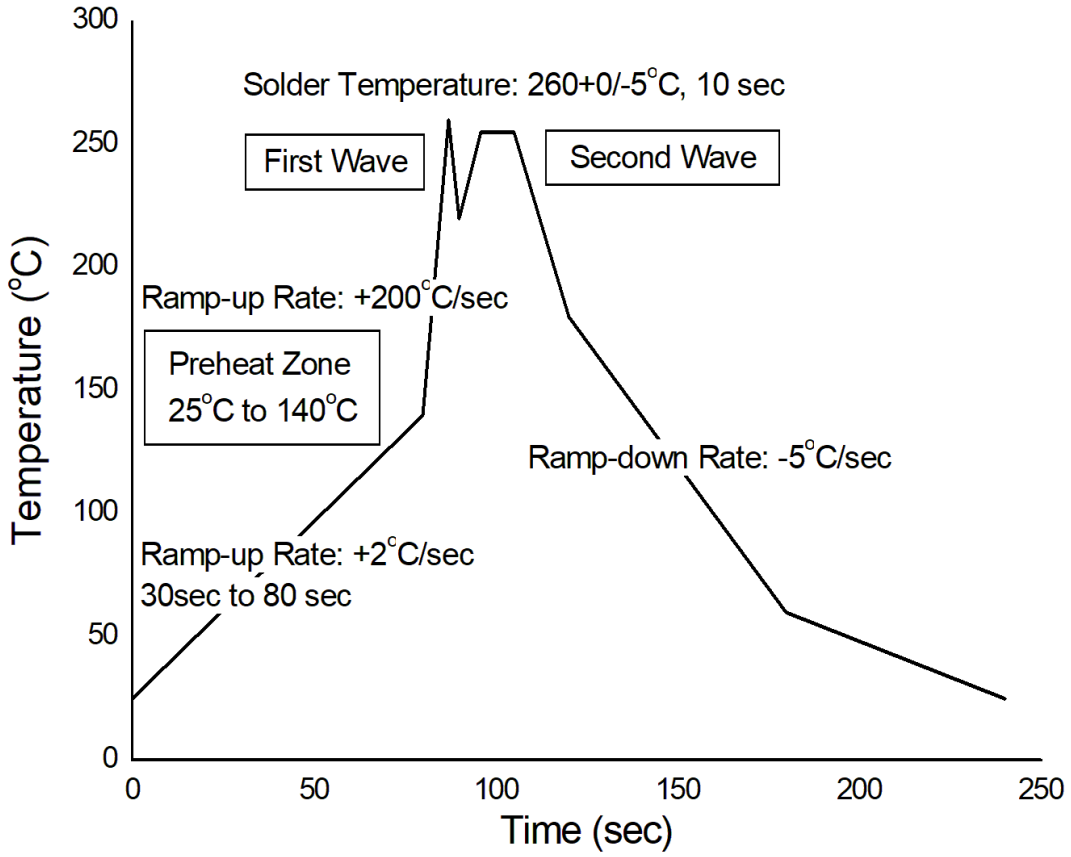
REFLOW PROFILE



Profile Feature	Sn-Pb Assembly Profile	Pb-Free Assembly Profile
Temperature Min. (Tsmin)	100°C	150°C
Temperature Max. (Tsmax)	150°C	200°C
Time (ts) from (Tsmin to Tsmax)	60-120 seconds	60-120 seconds
Ramp-up Rate (tL to tP)	3°C/second max.	3°C/second max.
Liquidous Temperature (TL)	183°C	217°C
Time (tL) Maintained Above (TL)	60 – 150 seconds	60 – 150 seconds
Peak Body Package Temperature	235°C +0°C / -5°C	260°C +0°C / -5°C
Time (tP) within 5°C of 260°C	20 seconds	30 seconds
Ramp-down Rate (TP to TL)	6°C/second max	6°C/second max
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

TEMPERATURE PROFILE OF SOLDERING

WAVE SOLDERING (JESD22-A111 COMPLIANT)



HAND SOLDERING BY SOLDERING IRON	
Soldering Temperature	380+0/-5°C
Soldering Time	3 sec max.
One time soldering is recommended for all soldering method.	
Do not solder more than three times for IR reflow soldering.	

DISCLAIMER

- WISELITE is continually improving the quality, reliability, function and design. WISELITE reserves the right to make changes without further notices.
- The characteristic curves shown in this datasheet are representing typical performance which are not guaranteed.
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- This product is not intended to be used for military, aircraft, medical, life sustaining or lifesaving applications or any other application which can result in human injury or death.
- Please contact WISELITE sales agent for special application request.
- Immerge unit's body in solder paste is not recommended.
- Parameters provided in datasheets may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated in each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify WISELITE's terms and conditions of purchase, including but not limited to the warranty expressed therein.
- Discoloration might be occurred on the package surface after soldering, reflow or long-time use. It neither impacts the performance nor reliability.

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