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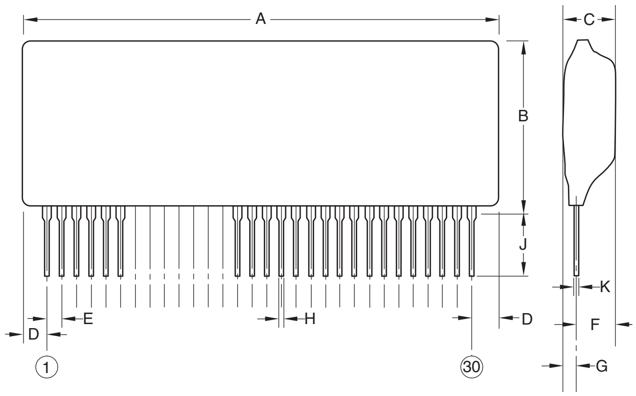
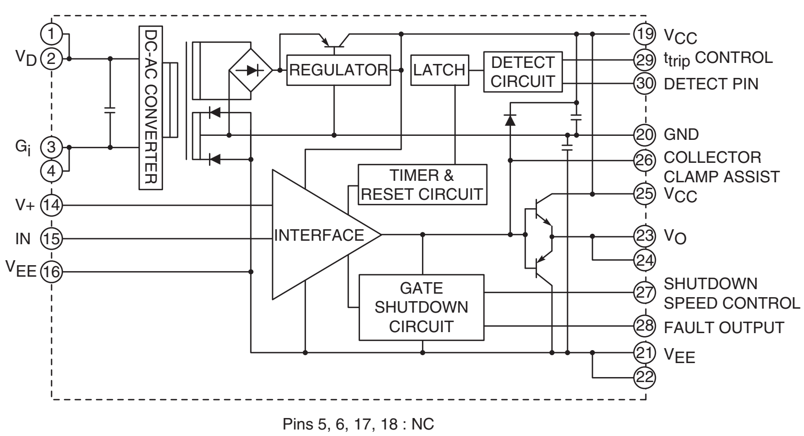
VLA554-01R

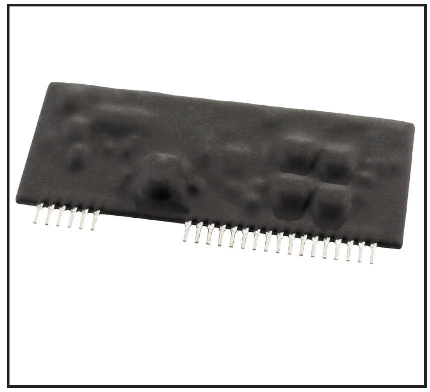
IGBT Gate Driver + DC/DC Converter





Circuit Diagram

Dimensions	Inches	Millimeters
A	3.46 Max.	88.0 Max.
B	1.67 Max.	42.5 Max.
C	0.67 Max.	17.0 Max.
D	0.31 Max.	8.0 Max.
E	0.1	2.54
F	0.45 Max.	11.5 Max.
G	0.24 Max.	6.0 Max.
H	0.03±0.004	0.75±0.1
J	0.14±0.04	3.5±1.0
K	0.028 Max.	0.7 Max.



Description:
VLA554-01R is a hybrid integrated circuit designed for driving n-channel IGBT modules in any gate-amplifier application. This device contains a fully isolated DC-DC converter designed to be used with a fiber optic interface for control signal input and fault signal output. The gate driver provides an over-current protection function based on desaturation detection.

Features:
- ☐ Built in Isolated DC-DC Converter for Gate Drive
- ☐ SIP Outline Allows More Space
- ☐ Built in Short Circuit Protection with a pin for Fault Output
- ☐ Built in Collector Clamp Circuit
- ☐ Variable Fall Time on Short-Circuit Protection
- ☐ Electrical Isolation Voltage 4000 V_{rms} (for 1 Minute)
- ☐ CMOS Compatible Input Interface
- ☐ Interfaces with Fiber Optic Connector for Isolation of Input Signal

Applications:
- ☐ To Drive IGBT Modules for General Industrial Use.

Recommended IGBT Modules:
V_{CES} = 1200V Series up to 3600A Class
V_{CES} = 1700V Series up to 3600A Class

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Absolute Maximum Ratings, T_a = 25°C unless otherwise specified

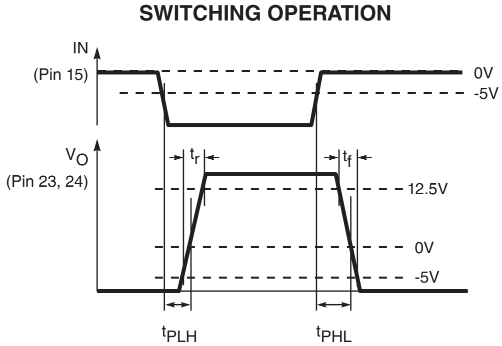
Characteristics	Symbol	Rating	Units
Supply Voltage (DC)	V_D	-1 ~ 16.5	Volts
Output Voltage ("H" Output Voltage)	V_O	V_{CC}	Volts
Input Current - Pulse(PW 10msec, Duty Cycle 50%, Applied Pin 1,2)	$I_{IN(PULSE)}$	4	Amperes
Output Current (Pulse Width 3μs)	I_{OHP}	-24	Amperes
	I_{OLP}	24	Amperes
Isolation Voltage (Sine Wave Voltage 60Hz, for 1 min., R.H. <60%)	V_{iso}	4000	V_{rms}
Case Temperature (Surface Temperature)	T_C	100	°C
Operating Temperature (No Condensation Allowable)	T_{opr}	-30 ~ 70	°C
Storage Temperature (No Condensation Allowable)	T_{stg}	-40 ~ 100*1	°C
Fault Output Current (Applied at Pin 28)	I_{FO}	20	mA
Input Voltage to Pin 30 (Applied at Pin 30)	V_{R30}	60	Volts
Gate Drive Current (Gate Average Current)	I_{drive}	210*2	mA

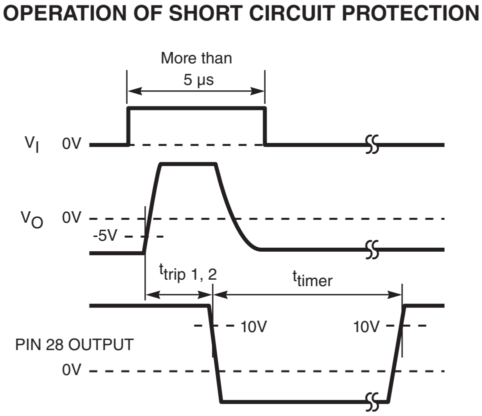
Electrical Characteristics, T_a = 25°C, V_D = 15V, R_G = 1Ω, C_L = 1.6μF, f = 3kHz unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage	V_D	Recommended Range	14.2	15	15.8	Volts
Switching Frequency	f	Recommended Range	—	—	10	kHz
Gate Resistance	R_G	Recommended Range	0.33	—	—	Ω
Gate Positive Supply Voltage	V_{CC}		15.2	16.5	17.5	Volts
Gate Negative Supply Voltage	V_{EE}		-6	-8	-11.5	Volts
Gate Supply Efficiency	η	Load Current = 210mA, $\eta = (V_{CC} + \lvert V_{EE}\rvert) \times 0.21 / (15 \times I_D) \times 100$	60	72	—	%
"H" Output Voltage	V_{OH}	10kΩ Connected Between Pins 23-20	14	15.3	16.5	Volts
"L" Output Voltage	V_{OL}	10kΩ Connected Between Pins 23-20	-5.5	-7	-11	Volts
"L-H" Propagation Time	t_{PLH}	I_{IH} = 30mA*3, Propagation Time from Pin 15	0.3	0.5	1.0	μs
"L-H" Rise Time	t_r	I_{IH} = 30mA*3	—	0.6	1.2	μs
"H-L" Propagation Time	t_{PHL}	I_{IH} = 30mA*3, Propagation Time from Pin 15	0.2	0.4	1.0	μs
"H-L" Fall Time	t_f	I_{IH} = 30mA*3	—	0.3	1.2	μs
Timer	t_{timer}	Between Start and Cancel (Under Input Sign "OFF")	1	—	2	ms
Fault Output Current	I_{FO}	Applied Pin 28, R = 2.4kΩ	—	10	—	mA
Controlled Time Detect Short Circuit 1	t_{trip1}	Pin 30: 15V and more, Pin 29: Open	—	3.5	—	μs
Controlled Time Detect Short Circuit 2*4	t_{trip2}	Pin 30: 15V and more, Pins 29-21, 22: 10pF (Connective Capacitance)	—	3.9	—	μs
SC Detect Voltage	V_{SC}	Collector Voltage of IGBT	15	—	—	Volts

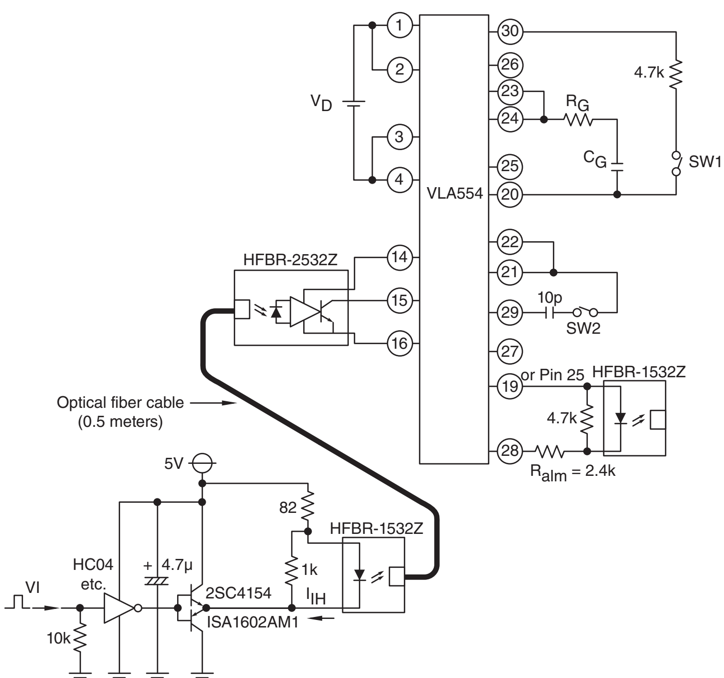
*1 Differs from H/C condition.
*2 Refer to I_{drive}-T_a characteristics.
*3 I_H is the current which flows through the LED in the optical link of the input interface. Refer to the Measurement Circuit schematic on page 3.
*4 Length of wiring of capacitor controlled time detect short-circuit is within 5cm from Pins 21, 22 and 29 coming and going.

Definition of Characteristics





Measurement Circuit

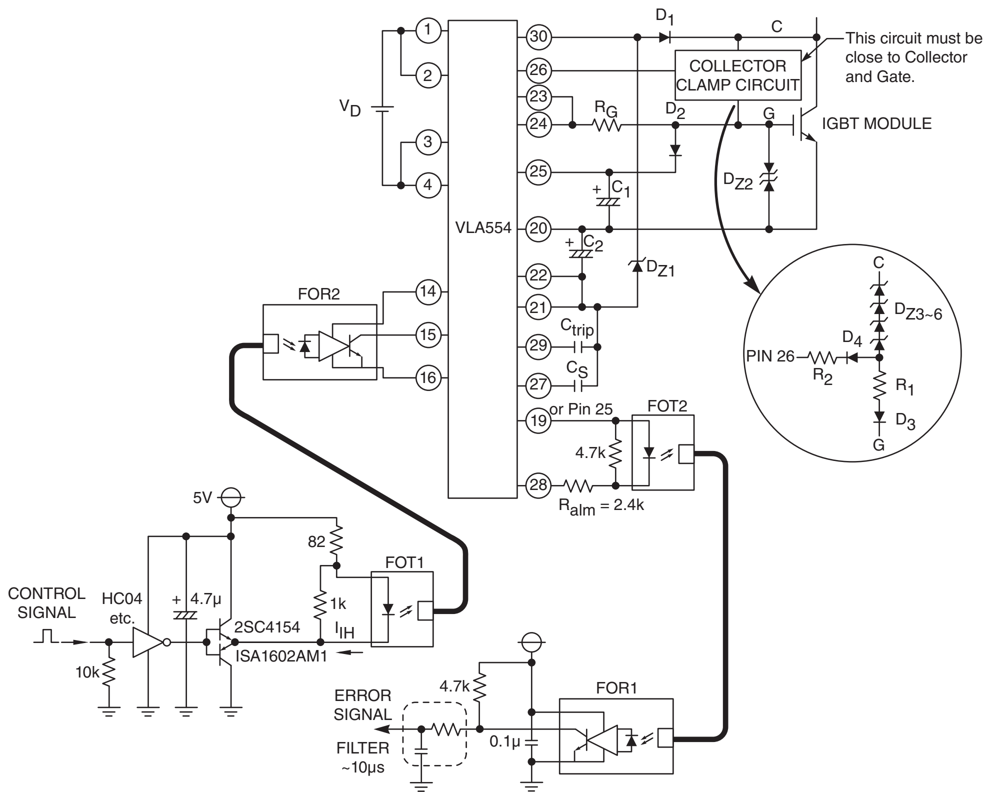


MEASUREMENT CONDITIONS

T_a = 25°C
V_D = 15V
R_G = 1Ω
C_G = 1.6µF

SW1 : ON → Switching Mode
SW1 : OFF → Short Circuit Protect Mode
SW2 : OFF → Measurement of t_{trip1}
SW2 : ON → Measurement of t_{trip2}

Application Example



V_D = 15V ±5%
FOT1,2 : HFBR-1532Z (AVAGO) etc.
FOR1,2 : HFBR-2532Z (AVAGO) etc.
C_{trip} : Depends on R_G
C_S : Depends on Surge Voltage
D_{Z1} : 30V, 0.5W~1W
D_{Z2} : 18V, Bidirectional
D_1 : Fast Recovery Diode (t_{rr} : 200ns max.) RP1H (SanKen) etc.
C_1, C_2 : 470μF, 35V (Low Impedance)

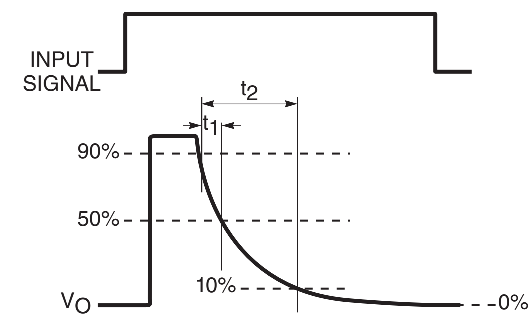
$D_{2\sim4}$: SBD V_{RM} = 60V, IF_{SM} > 60A Class
R_1 : 1Ω, 1W Class
R_2 : 10Ω, 1/4W Class
$D_{Z3\sim6}$: Vpn < Total V_Z < V_{CES} of IGBT
Rough guide of total V_Z is as follows:
For V_{CES} 1200V Series → 900~1000V
For V_{CES} 1700V Series → 1300~1400V
It depends on Vpn, $I_{C(max)}$, R_G, snubber circuit inductance of power main circuit, and kind of main condenser.

NOTE:
1. Decoupling capacitors should be located as close as possible to the Hybrid IC pins.
2. The gate circuit path should be kept as short as possible to minimize influence of switching noise.
3. D_1 requires approximately the same blocking voltage as the IGBT modules.
4. When recovery current flows in D_1, Pin 30 sees high voltage. A zener diode between Pin 21 and Pin 30 is necessary as shown in above diagram.
5. To decrease the speed of output fall time (reverse bias) when protection circuit is operating, connect C_S between Pin 21 and Pin 27.
6. If the short-circuit protection circuit is not used, please connect a 4.7k ohm resistor between Pin 30 and Pin 20. (D_1 and D_{Z1} are not required.)
7. If the collector clamp circuit is activated repeatedly, it may be destroyed as a result of overheating. For this reason, power dissipation of the zener diode should be determined by testing in the actual inverter.

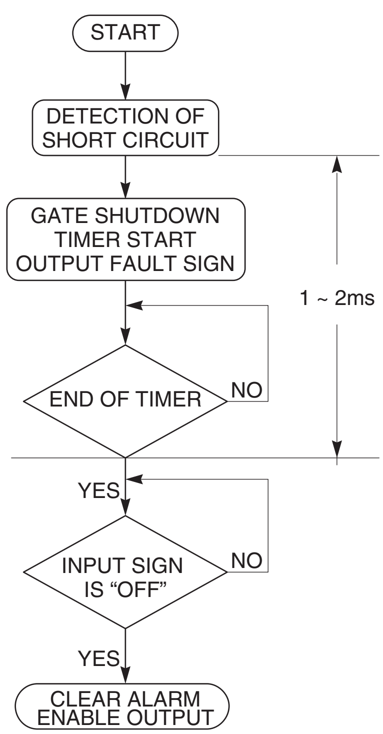
Operation of Protection Circuit

1. When an "ON" input signal is applied for a period longer than Ttrip and the collector voltage is high, the hybrid IC will recognize the condition as a short-circuit and immediately reduce the gate voltage. It will also produce a low voltage fault signal at the respective Pin 28 alerting that the protection circuit is in operation.
2. The protection circuit will reset if an "OFF" input signal is applied and the minimum 1~2ms shutdown time has passed. "OFF" signal must be 15µs or more.
3. The controlled time to detect a short-circuit (Ttrip) should be set so that the IGBT can be fully turned "ON" before a short-circuit condition can be detected. It is possible to adjust Ttrip by connecting a capacitor (Ctrip) between Pins 21, 22 and 29.
4. When the short-circuit protection is activated, the soft gate shutdown circuit reduces the collector surge voltage on the IGBT. The gate shut down speed can be slowed even more by adding a capacitor to the CS terminal (between Pins 21, 27).

Adjustment of Output Fall Time

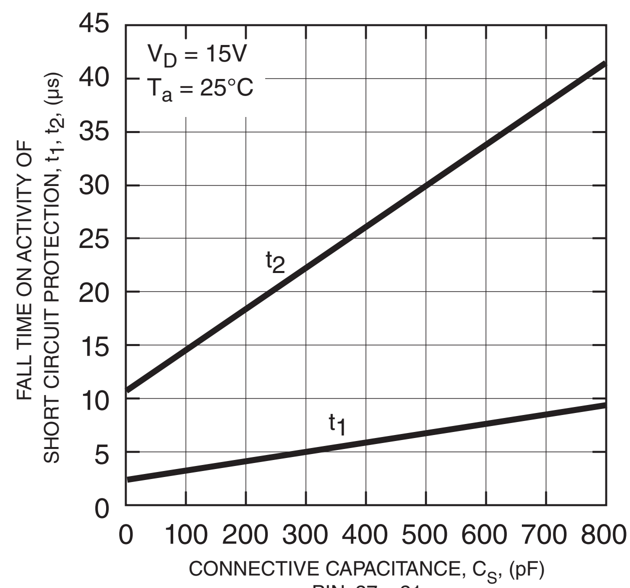


Operation Flow on Detecting Short Circuit



NOTE: Output voltage with protection circuit operating is about -IV_{EE}I + 2V

t1, t2 vs C_S CHARACTERISTICS (TYPICAL)



Capacity for Power Supply on Input Side

This product has an isolated DC-DC converter built in for gate drive. Follow these three steps to determine the proper capacity of the power supply on the input side.

1. Calculate the average gate current.

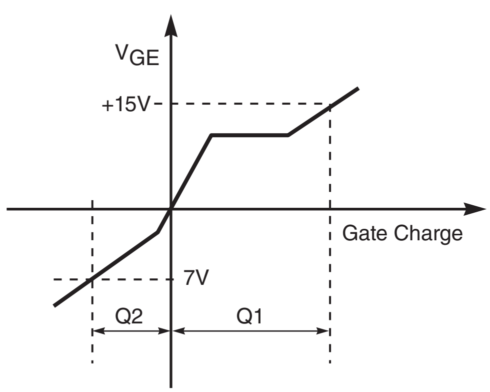
$$I_{drive} = (Q1 + |Q2|) \times F$$

I_{drive} : Gate average current
Q1 : Gate charge at +15V (read from IGBT datasheet)
Q2 : Gate charge at -7V (read from IGBT datasheet)
f : Switching frequency of IGBT

2. Required current from performance curve.

If the result of the calculation for I_{drive} is 100mA, I_D is about 270mA as shown on the graph.
I_D : Consumption current of DC-DC converter in this HIC

GATE CHARGE CHARACTERISTICS OF IGBT



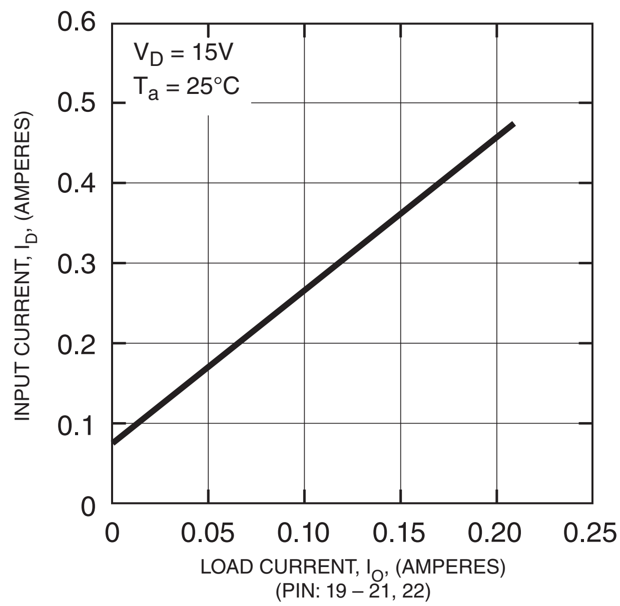
3. Calculate the margin

$$I_{out} = I_D \times (1 + \text{margin})$$

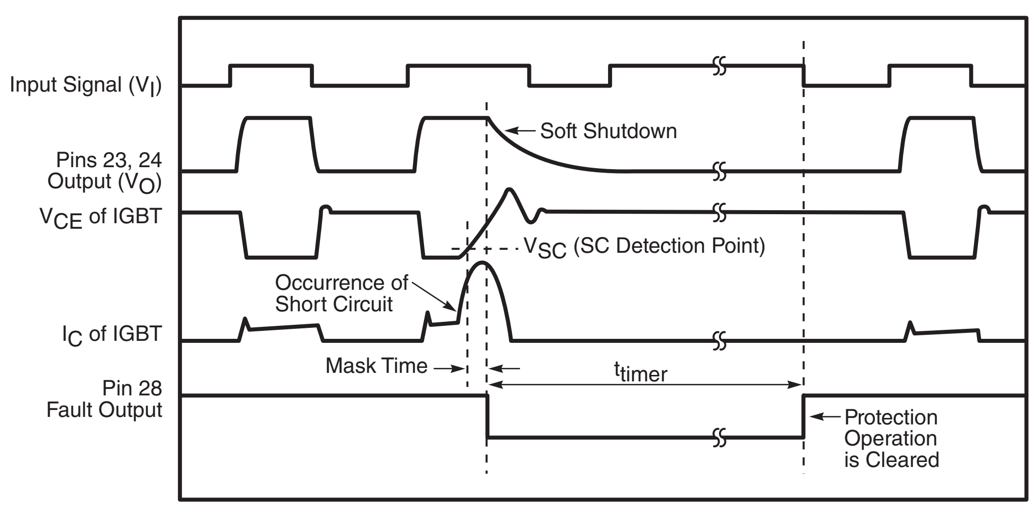
I_{out} : Output current of input power supply
Margin : 0.4

If the result of I_D is 270mA, the power supply spec is:
Output voltage : 15V
Output current : greater than 350mA

I_D – I_O CHARACTERISTICS (TYPICAL)



Timing Chart



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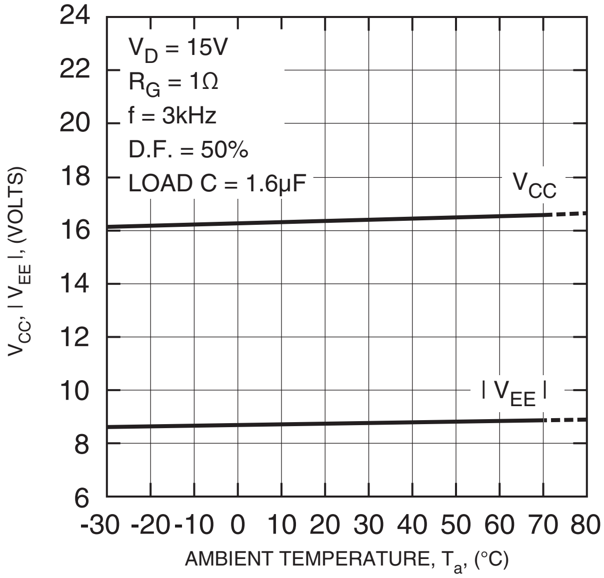
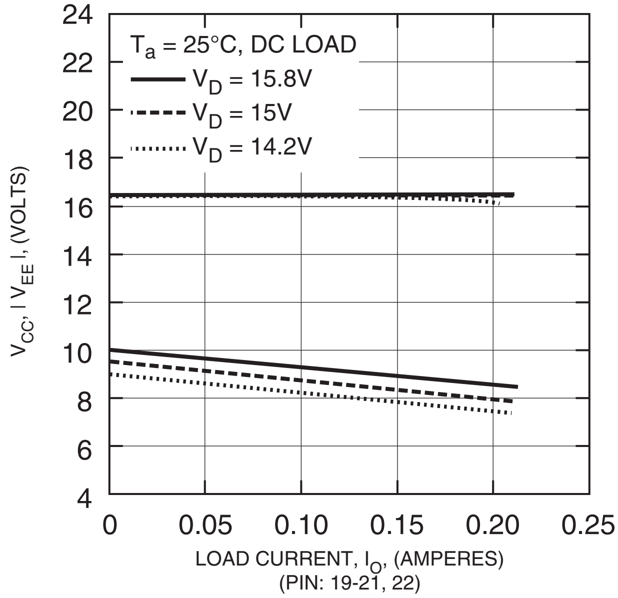
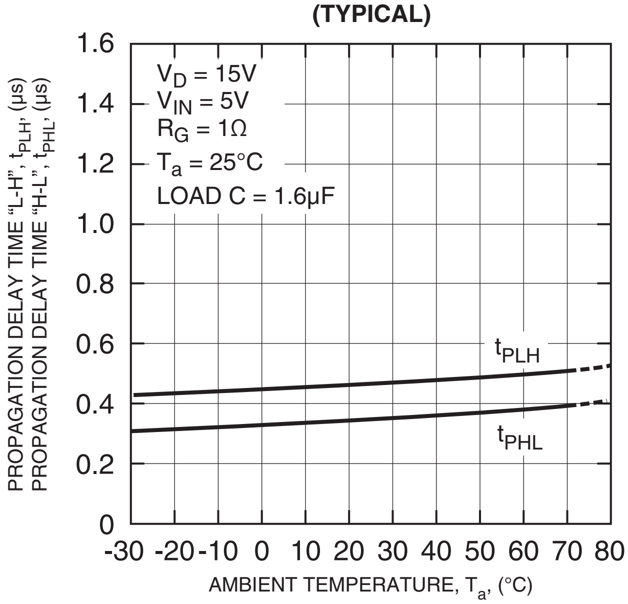
V_{CC}, | V_{EE} | -T_a CHARACTERISTICS (TYPICAL)



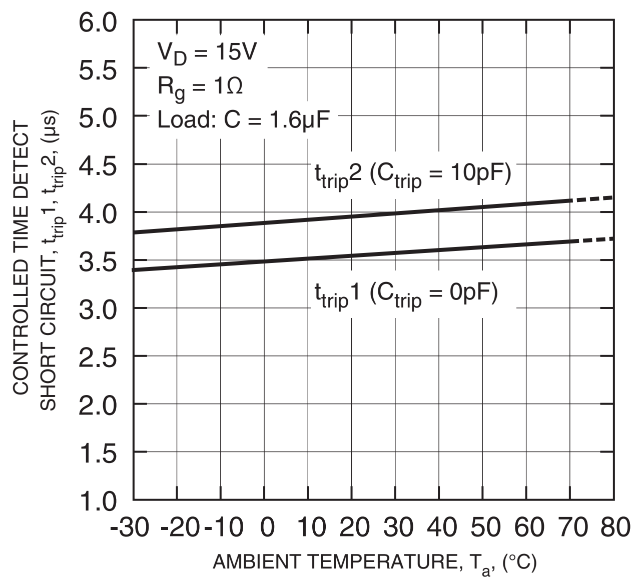
V_{CC}, | V_{EE} | -I_O CHARACTERISTICS (TYPICAL)



t_{PLH}, t_{PHL}-T_a CHARACTERISTICS (TYPICAL)



t_{trip}-T_a CHARACTERISTICS (TYPICAL)



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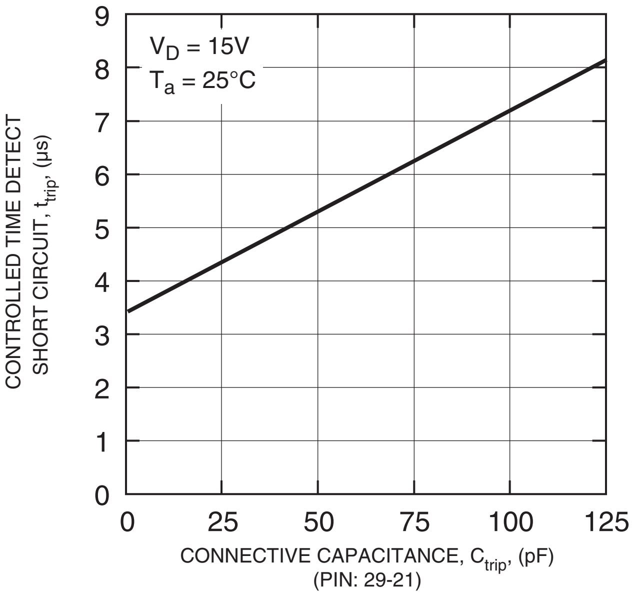
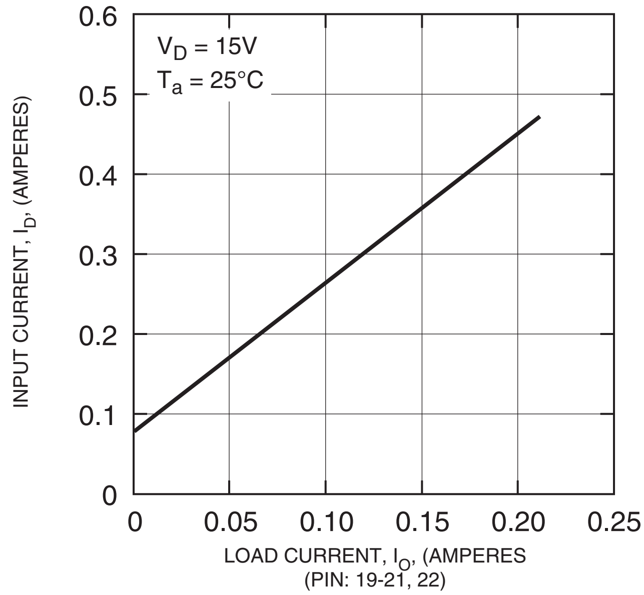
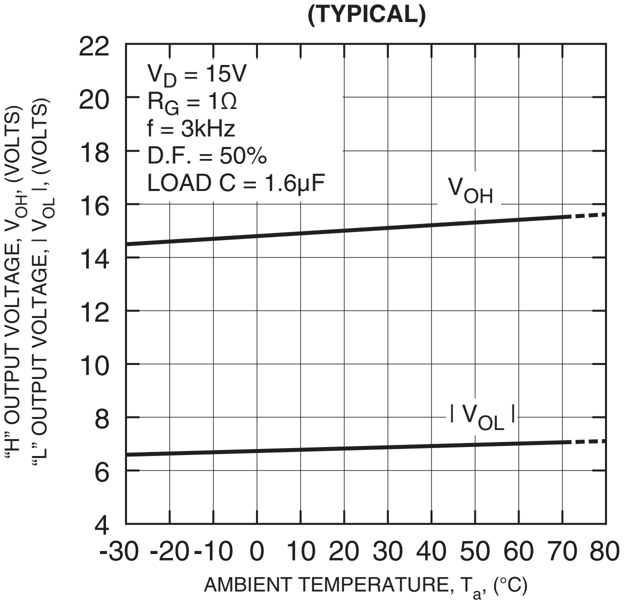
t_{trip}-C_{trip} CHARACTERISTICS (TYPICAL)



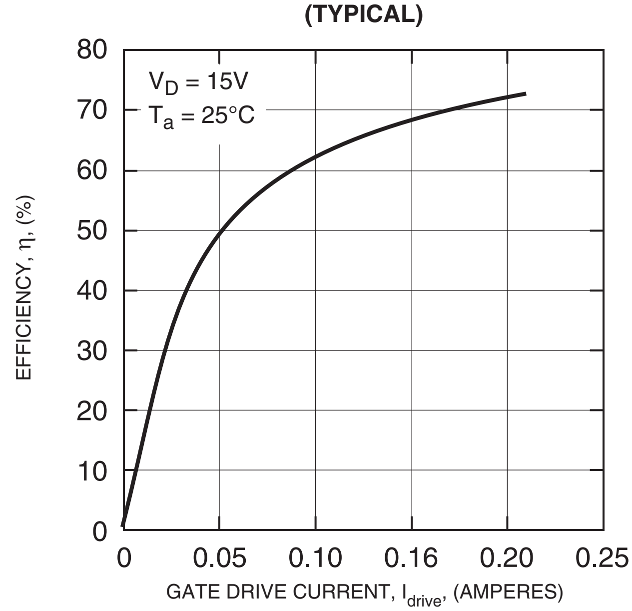
I_D-I_O CHARACTERISTICS (TYPICAL)

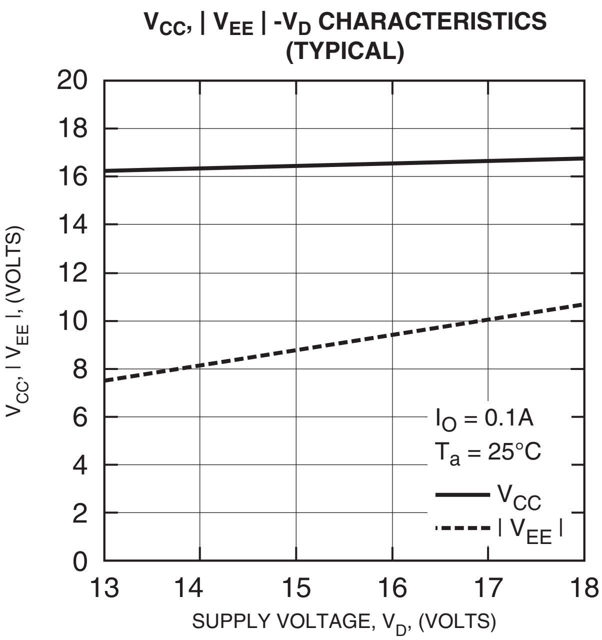


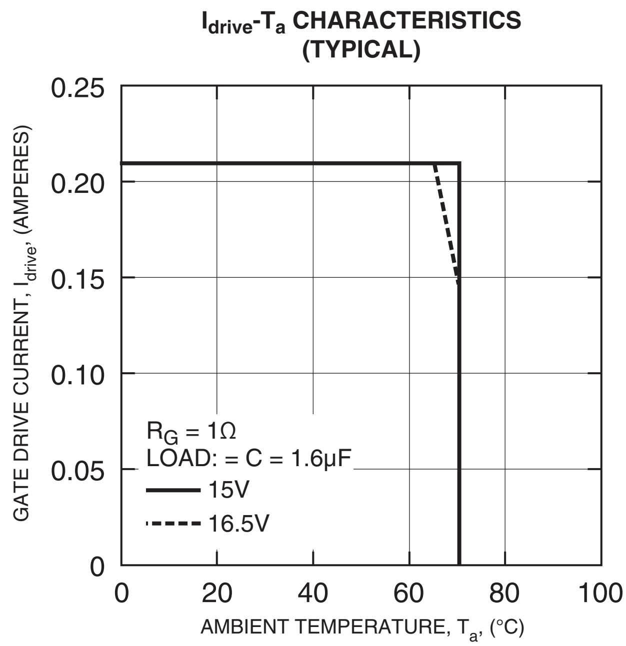
V_{OH}, | V_{OL} | -T_a CHARACTERISTICS (TYPICAL)

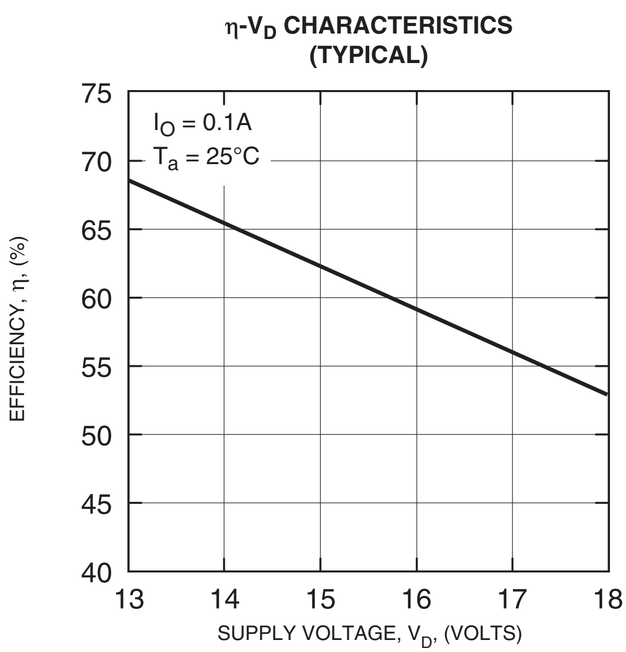


η-I_{drive} CHARACTERISTICS (TYPICAL)




VCC, | VEE | -VD CHARACTERISTICS
(TYPICAL)
VCC, | VEE |, (VOLTS)
20
18
16
14
12
10
8
6
4
2
0
13
14
15
16
17
18
SUPPLY VOLTAGE, VD, (VOLTS)
IO = 0.1A
Ta = 25°C
VCC
| VEE |


Idrive-Ta CHARACTERISTICS
(TYPICAL)
GATE DRIVE CURRENT, Idrive, (AMPERES)
0.25
0.20
0.15
0.10
0.05
0
20
40
60
80
100
AMBIENT TEMPERATURE, Ta, (°C)
RG = 1Ω
LOAD: = C = 1.6μF
15V
16.5V


η-VD CHARACTERISTICS
(TYPICAL)
EFFICIENCY, η, (%)
75
70
65
60
55
50
45
40
13
14
15
16
17
18
SUPPLY VOLTAGE, VD, (VOLTS)
IO = 0.1A
Ta = 25°C