Dual-channel Intelligent High-side Driver

FEATURES

- AEC-Q100 result certification in progress:
  – Temperature grade 1: - 40°C to +125°C, T_A
- N-MOS Dual-channel high-side Driver
- Wide 5V to 28V Operating Voltage
- Compatible with 3V and 5V CMOS outputs
- Ultra low standby current
- MultiSense diagnostic functions
  - Current mirror of output current,voltage propotional to VCC or chip temperature
  - Overload and short to ground (power limitation) indication
  - Thermal shutdown indication
  - OFF-state open-load detection
  - Output short to VCC detection
- Ultra-low Rdson 35mΩ
- Protections function
  - VCC Under voltage shutdown
  - Overvoltage Clamp
  - Load current Limitation
  - Configurable latch-off on overtemperature or power limitation with dedicated fault reset pin
  - Self limiting of fast thermal transients
  - Reverse battery with external components
- Package
  - DFN6X5-16

APPLICATIONS

- LED driver, bulb driver
- Specially intended for Automotive Signal Lamps
- Dual-channel Intelligent High-side Driver
- Solenoids, Values, Relays
- General Resistive, Capatitive, Inductive Loads

GENERAL DESCRIPTION

The TMI82H05D-Q1 is a double channel high-side driver, The device is designed to drive 12V automotive grounded loads through a 3V and 5V CMOS-compatible interface, providing protection and diagnostics.

The device integrates advanced protective functions such as load current limitation, overload active management by power limitation and overtemperature shutdown with configurable latch-off.

A $\overline{\text{FaultRST}}$ pin unlatches the output in case of fault or disables the latch-off functionality.

A dedicated multifunction multiplexed analog output pin delivers sophisticated diagnostic functions including high precision proportional load current sense, supply voltage feedback and chip temperature sense, in addition to the detection of overload and short circuit to ground, short to VCC and OFF-state open-load.

A sense enable pin allows OFF-state diagnosis to be disabled during the module low-power mode as well as external sense resistor sharing among similar devices.

TYPICAL APPILCATION

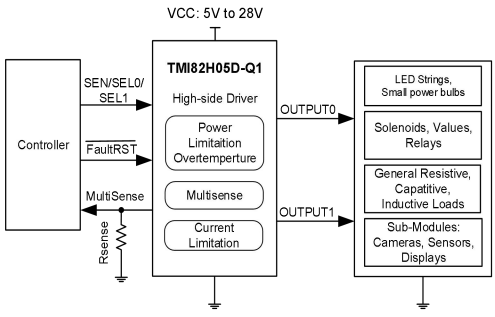


Figure 1. Simplified Schematic

ABSOLUTE MAXIMUM RATINGS(Note 1)

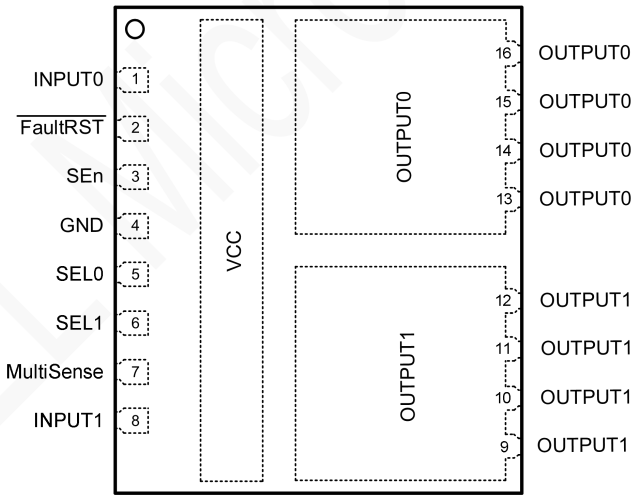
Parameter	Min	Max	Unit
Power supply voltage (VCC)	-0.3	40	V
Output pin voltage	-0.7	VCC	V
FaultRST DC input voltage	-0.3	6	V
FaultRST DC input current	-1	10	mA
$INPUT_{0,1}$ DC input current	-1	10	mA
SEn DC input current	-1	10	mA
$SEL_{0,1}$ DC input current	-1	10	mA
Operating junction temperature(Note 2)	-40	125	°C
Storage temperature	-40	150	°C

ESD RATING

Items	Description	Value	Unit
V_{ESD}	Human body model (HBM)	±4000	V
	Charged device model (CDM)	±750	V

AEC-Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

PACKAGE/ORDER INFORMATION



DFN6X5-16(Top view)

TMI82H05D-Q1/XXXXX (TMI82H05D-Q1: Device Code, XXXXX: Inside Code) for TMI82H05D-Q1

Part Number	Package	Top mark	Quantity/ Reel
TMI82H05D-Q1	DFN6X5-16	TMI82H05D-Q1 XXXXX	5000

The TMI82H05D-Q1 device is Pb-free and RoHS compliant.

PIN FUNCTIONS

Pin			Function
Number	Name	I/O	
1	INPUT0	I	Voltage controlled input pin with hysteresis, compatible with 3V and 5V CMOS outputs. It controls output switch state.
2	FaultRST	I	Active low compatible with 3V and 5V CMOS outputs pin; it unlatches the output in case of fault; If kept low, sets the outputs in auto-restart mode.
3	SEn	I	Active high compatible with 3V and 5V CMOS outputs pin; it enables the MultiSense diagnostic pin.
4	GND	-	Ground connection. Must be reverse battery protected by an external diode / resistor network.
5	SEL0	I	Active high compatible with 3V and 5V CMOS outputs pin; they address the MultiSense multiplexer.
6	SEL1	I	Active high compatible with 3V and 5V CMOS outputs pin; they address the MultiSense multiplexer.
7	MultiSense	O	Multiplexed analog sense output pin; it delivers a current proportional to the selected diagnostic: load current, supply voltage or chip temperature.
8	INPUT1	I	Voltage controlled input pin with hysteresis, compatible with 3V and 5V CMOS outputs. It controls output switch state.
9,10,11,12	OUTPUT1	O	Power output1.
13,14,15,16	OUTPUT0	O	Power output0.
Pad	VCC	-	Battery connection.

Table 1: Suggested connections for unused and not connected pins

Connection / pin	MultiSense	N.C	Output	Input	SEn, SELx, FaultRST
Floating	Not allowed	X(1)	X	X	X
To ground	Through 1 kΩ resistor	X	Diode	Through 15 kΩ resistor	Through 15 kΩ resistor

Notes:

(1)X: do not care.

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
VCC	Power supply voltage range	5	28	V
INPUT 0,1	Voltage on INPUT	0	5.5	V
SEN	Voltage on SEN	0	5.5	V
SEL0,1	Voltage on SEL0,1	0	5.5	V
FaultRST	Voltage on FaultRST	0	5.5	V
T_A	Operating ambient temperature	-40	125	°C

Thermal Information

THERMAL METRIC			Unit
$R_{thj-board}$	Junction-to-board therma resistance (JEDECJESD 51-5/51-8)(3)	6.65	°C/W
$R_{thj-amb}$	Junction-to-ambient thermal resistance (JEDECJESD 51-5)(2)	57.5	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient (JEDEC JESD 51-7)(1)(2)	26.8	°C/W

Notes:

(1) One channel ON.

(2) Device mounted on 2s2p four layers PCB.

(3) Device mounted on 2s0p two layers PCB with 2 cm^2 heatsink copper trace.

TOLL Microelectronic

ELECTRICAL CHARACTERISTICS

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Power section (Vcc)						
VCC operating voltage	Vcc		5		28	V
VCC undervoltage lockout voltage	V_{UVLO}				4	V
Undervoltage shutdown reset	$V_{uvloreset}$				5	V
Undervoltage shutdown hysteresis	$V_{uvlohyst}$			0.4		V
On-state resistance	R_{ON}	I_{OUT}=2A; Tj=25°C		35		mΩ
		I_{OUT}=2A; Tj=125°C			80	
Clamp voltage	V_{clamp}	I_S=20mA; 25°C<Tj<125°C	41	45	48	V
Supply current in standby at V_{CC} =13V	I_{STBY}	V_{CC}=13V; V_{IN}=V_{OUT}=V_{FR}=V_{SEn}=0V; $V_{SEL0,1}$=0V; Tj=25°C			0.5	μA
		V_{CC}=13V; V_{IN}=V_{OUT}=V_{FR}=V_{SEn}=0V; $V_{SEL0,1}$=0V; Tj=85°C			0.5	
		V_{CC}=13V; V_{IN}=V_{OUT}=V_{FR}=V_{SEn}=0V; $V_{SEL0,1}$=0V; Tj=125°C			3	
Standby mode blanking time	t_{D_STBY}	V_{CC}=13V; V_{IN}=V_{OUT}=V_{FR}=$V_{SEL0,1}$=0V; V_{SEn}=5V to 0V	60	300	500	μs
Supply current	$I_{S(ON)}$	V_{CC}=13V; V_{SEn}=V_{FR}=$V_{SEL0,1}$=0V; V_{IN0}=5V; V_{IN1}=5V; I_{OUT0}=0A;I_{OUT1}=0A			5	mA
Control stage current consumption in ON state. All channels active	$I_{GND(ON)}$	V_{CC}=13V; V_{SEn}=V_{FR}=$V_{SEL0,1}$=0V; V_{IN0}=5V; V_{IN1}=5V; I_{OUT0}=2A; I_{OUT1}=2 A		3	5	mA
Off-state output current at V_{CC} =13V	$I_{L(off)}$	V_{IN}=V_{OUT}=0V; V_{CC}=13 V; Tj=25°C	0	0.02	0.5	μA
		V_{IN}=V_{OUT}=0V; V_{CC}=13V; Tj=125°C	0		3	
Output-Vcc diode voltage	V_F	Iout=-2A; Tj=125°C		0.7	0.9	V

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Switching time(see Figure 2)						
Turn-on delay time at Tj = 25 °C	td(on)	R_L = 6.5 Ω	10	60	120	µs
Turn-off delay time at Tj = 25 °C	td(off)		10	60	100	µs
Turn-on voltage slope at Tj = 25 °C	$(dV_{OUT}/dt)_{on}$	R_L = 6.5 Ω	0.1	0.3	0.7	V/µs
Turn-off voltage slope at Tj = 25 °C	$(dV_{OUT}/dt)_{off}$		0.1	0.32	0.7	
Switching energy losses at turn-on	W_{ON}	R_L = 6.5 Ω	-	0.25	0.33	mJ
Switching energy losses at turn-off	W_{OFF}		-	0.23	0.31	mJ
Differential Pulse skew (tPHL - tPLH)	t_{SKEW}	R_L = 6.5 Ω	-50	-10	30	µs
INPUT0,1 characteristics						
Input low level voltage	V_{IL}				0.9	V
Low level input current	I_{IL}	V_{IN}=0.9V	1		10	µA
Input high level voltage	V_{IH}		2.1			V
High level input current	I_{IH}	V_{IN}=2.1V			10	µA
Input hysteresis voltage	$V_{I(hyst)}$		0.3	0.4		V
Input clamp voltage	V_{ICL}	I_{IN} =1mA	5.3		7.2	V
		I_{IN} =-1mA		-0.7		
FaultRST characteristics						
Input low level voltage	V_{FRL}				0.9	V
Low level input current	I_{FRL}	V_{IN} =0.9V	1		10	µA
Input high level voltage	V_{FRH}		2.1			V
High level input current	I_{FRH}	V_{IN} =2.1V			10	µA
Input hysteresis voltage	$V_{FR(hyst)}$		0.3	0.4		V
Input clamp voltage	V_{FRCL}	I_{IN} =1mA	5.3		7.2	V
		I_{IN} =-1mA		-0.7		
SEL0,1 characteristics						
Input low level voltage	V_{SELL}				0.9	V
Low level input current	I_{SELL}	V_{IN} =0.9V	1		10	µA
Input high level voltage	V_{SELH}		2.1			V
High level input current	I_{SELH}	V_{IN} =2.1V			10	µA
Input hysteresis voltage	$V_{SEL(hyst)}$		0.3	0.4		V

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input clamp voltage	V_{SELCL}	I_{IN} =1mA	5.3		7.2	V
		I_{IN} =-1mA		-0.7		
SEn characteristics						
Input low level voltage	V_{SELL}				0.9	V
Low level input current	I_{SELL}	V_{IN} =0.9V	1		10	μA
Input high level voltage	V_{SELH}		2.1			V
High level input current	I_{SELH}	V_{IN} =2.1V			10	μA
Input hysteresis voltage	$V_{SEL(hyst)}$		0.3	0.4		V
Input clamp voltage	V_{SELCL}	I_{IN} =1mA	5.3		7.2	V
		I_{IN} =-1mA		-0.7		
SEn characteristics						
Input low level voltage	V_{SEnL}				0.9	V
Low level input current	I_{SEnL}	V_{IN} =0.9V	1		10	μA
Input high level voltage	V_{SEnH}		2.1			V
High level input current	I_{SEnH}	V_{IN} =2.1V			10	μA
Input hysteresis voltage	$V_{SEn(hyst)}$		0.3	0.4		V
Input clamp voltage	V_{SEnCL}	I_{IN} =1mA	5.3		7.2	V
		I_{IN} =-1mA		-0.7		
Protections						
DC short circuit current	I_{LIMH}	V_{CC} =13V	21	30	42	A
		5V<V_{CC}<28V				
Short circuit current during thermal cycling	I_{LIML}	V_{CC}=13 V; T_R<T_j<T_{TSD}		10		
Shutdown temperature	T_{TSD}		150	175	190	°C
Reset temperature	T_R		T_{RS} + 1	T_{RS} + 7		
Thermal reset of fault diagnostic indication	T_{RS}	V_{FR}=0V; V_{SEn}=5 V	135			
Thermal hysteresis (T_{TSD} -T_R)	T_{HYST}			7		
Dynamic temperature	ΔT_{J_SD}	T_j =-40°C; VCC =13V		60		K
Fault reset time for output unlatch	t_{LATCH_RST}	V_{FR} =5V to 0V; V_{SEn}=5V; V_{IN}=5V; V_{SEL0}=0V; V_{SEL1}=0V	3	10	20	μs
Output voltage drop limitation	V_{ON}	I_{OUT} =0.2A		20		mV
MultiSense						
MultiSense clamp voltage	V_{SENSE_CL}	V_{SEn}=0V; I_{SENSE}=1mA	5		8	V
		V_{SEn}=0V; I_{SENSE}=-1mA	-0.5		-0.7	

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Current sense characteristics						
I_{OUT}/I_{SENSE}	K_0	I_{OUT}=0.05A; V_{SENSE}=0.5V;	900	1500	1200	
Current Sense ratio drift	dK_0/K_0	V_{SEn}=5V	-20		20	%
I_{OUT}/I_{SENSE}	K_1	I_{OUT}=0.2A; V_{SENSE}=0.5V;	1250	1500	1750	
CurrentSense ratio drift	dK_1/K_1	V_{SEn}=5V	-15		15	%
I_{OUT}/I_{SENSE}	K_2	I_{OUT}=1.5A; V_{SENSE}=4V; V_{SEn}=5V	1350	1500	1650	
Current Sense ratio drift	dK_2/K_2		-7		7	%
I_{OUT}/I_{SENSE}	K_3	I_{OUT}=4.5A; V_{SENSE}=4V; V_{SEn}=5V	1400	1500	1600	
Current Sense ratio drift	dK_3/K_3		-6		6	%
MultiSense leakage current	I_{SENSE0}	MultiSense disabled: V_{SEn} =0V	0		0.5	µA
		MultiSense disabled: -1V<V_{SENSE}<5V	-0.5		0.5	
		MultiSense enabled: V_{SEn}=5V; All channels ON; I_{OUTX}=0A; ChX diagnostic selected • E.g.Ch0: V_{IN0}=5 V; V_{IN1}=5V; V_{SEL0} =0V; V_{SEL1}=0V; I_{OUT0}=0A; I_{OUT1}=2A	0		2	
		MultiSense enabled: V_{SEn}=5V; ChX channel OFF; ChX diagnostic selected: • E.g.Ch0： V_{IN0}=0 V; V_{IN1}=5V; V_{SEL0} =0V; V_{SEL1}=0V; I_{OUT1}=2A	0		2	
Multisense saturation voltage	V_{SENSE_SAT}	V_{CC}=7V; R_{SENSE} =2.7kΩ; V_{SEn}=5V; V_{IN0}=5V; V_{SEL0}=0V; V_{SEL1}=0V; I_{OUT0}=4.5 A; T_j =125°C	5			V
Multisense saturation current	I_{SENSE_SAT}	V_{CC}=7V; V_{SENSE}=4V; V_{IN0}=5V; V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=0V; T_j=125°C	3	4	6	mA
Output saturation current	I_{OUT_SAT}	V_{CC}=7V; V_{SENSE}=4V; V_{IN0}=5V; V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=0V; T_j=125°C	6			A

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF-state diagnostic						
OFF-state openload voltage detection threshold	V_{OL}	V_{SEn}=5V; ChX OFF; ChX diagnostic selected • E.g: Ch0 V_{IN0}=0V; V_{SEL0}=0V; V_{SEL1}=0V	2	3	4	V
OFF-state output sink current	$I_{L(off2)}$	V_{IN}=0V; V_{OUT} =V_{OL}	-800		-500	µA
OFF-state diagnostic delay time from falling edge of INPUT(see Figure 5)	t_{DSTKON}	V_{SEn}=5V; ChX ON to OFF transition; ChX diagnostic selected • E.g: Ch0 V_{IN0}=5V to 0V; V_{SEL0}=0V; V_{SEL1}=0V; I_{OUT0}=0A; V_{OUT}=4V	100	350	700	µs
Settling time for valid OFF-state open load diagnostic indication from rising edge of SEn	$t_{D_OL_V}$	V_{IN0}=0V; V_{IN1}=0V; V_{FR}=0V; V_{SEL0}=0V; V_{SEL1}=0V; V_{OUT0}=4V; V_{SEn}=0V to 5V			60	µs
OFF-state diagnostic delay time from rising edge of V_{OUT}	t_{D_VOL}	V_{SEn}=5V; ChX OFF; ChX diagnostic selected • E.g: Ch0 V_{IN0}=0V; V_{SEL0}=0V; V_{SEL1}=0V; V_{OUT} =0V to 4V		5	30	µs
Chip temperature analog feedback						
MultiSense output voltage proportional to chip temperature(Note 3)	V_{SENSE_TC}	V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=5V; $V_{IN0,1}$=0V; R_{SENSE}=1kΩ; T_j=-40°C	2.3	2.4	2.5	V
		V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=5V; $V_{IN0,1}$=0V; R_{SENSE}=1kΩ; T_j=25°C	1.98	2.02	2.2	
		V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=5V; $V_{IN0,1}$=0V; R_{SENSE}=1kΩ; T_j=125°C	1.43	1.5	1.58	
Temperature coefficient	dV_{SENSE_TC}/dT	T_j=-40°C to 125°C		-5.5		mV/K
VCC supply voltage analog feedback						
MultiSense output voltage proportional to VCC supply voltage(Note 3)	V_{SENSE_VCC}	V_{CC}=13V; V_{SEn}=5V; V_{SEL0}=5V; V_{SEL1}=5V; $V_{IN0,1}$=0V; R_{SENSE}=1kΩ	3.16	3.35	3.45	V
Transfer function		V_{SENSE_VCC} = V_{CC} / 4				

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Fault diagnostic feedback						
MultiSense output voltage in fault condition	V_{SENSEH}	V_{CC} =13V; R_{SENSE} =1kΩ; • E.g: Ch0 in open load V_{IN0}=0V; V_{SEn}=5V; V_{SEL0}=0V; V_{SEL1}=0V; I_{OUT0}=0 A; V_{OUT}=4V	5		6.7	V
MultiSense output current in fault condition	I_{SENSEH}	V_{CC}=13V; V_{SENSE}=5V	20	30	40	mA
MultiSense timings(current sense mode-see Figure 3: "MultiSense timings (current sense mode)")						
Current sense settling time from rising edge of SEn	$t_{DSENSE1H}$	V_{IN}=5V; V_{SEn} =0V to 5V; R_{SENSE} =1kΩ; R_L=6.5Ω			60	µs
Current sense disable delay time from falling edge of SEn	$t_{DSENSE1L}$	V_{IN}=5V; V_{SEn} =5V to 0V; R_{SENSE}=1kΩ; R_L=6.5Ω		5	20	µs
Current sense settling time from rising edge of INPUT	$t_{DSENSE2H}$	V_{IN} =0V to 5V; V_{SEn}=5V; R_{SENSE} =1kΩ; RL=6.5Ω		100	250	µs
Current sense turnoff delay time from falling edge of INPUT	$t_{DSENSE2L}$	V_{IN} =5V to 0V; V_{SEn}=5V; R_{SENSE} =1kΩ; R_L=6.5Ω		20	100	µs
MultiSense timings (chip temperature sense mode- see Figure 4: "Multisense timings (chip temperature and VCC sense mode)")						
V_{SENSE_TC} settling time from rising edge of SEn	$t_{DSENSE3H}$	V_{SEn}=0V to 5V; V_{SEL0}=0V; V_{SEL1} = 5V; R_{SENSE} =1kΩ			60	µs
V_{SENSE_TC} disable delay time from falling edge of SEn	$t_{DSENSE3L}$	V_{SEn}=5V to 0V; V_{SEL0}=0V; V_{SEL1} = 5V; R_{SENSE} =1kΩ			20	µs
MultiSense timings (VCC voltage sense mode- see Figure 4: "Multisense timings (chip temperature and VCC sense mode)")						
V_{SENSE_VCC} settling time from rising edge of SEn	$t_{DSENSE4H}$	V_{SEn} =0V to 5V; V_{SEL0} =5V; VSEL1 =5V; R_{SENSE} =1 kΩ			60	µs
V_{SENSE_VCC} disable delay time from falling edge of SEn	$t_{DSENSE4L}$	V_{SEn}=5V to 0 V; V_{SEL0} =5V; V_{SEL1} =5V; R_{SENSE}=1kΩ			20	µs
MultiSense timings (Multiplexer transition times)						
MultiSense transition delay from Chx to Chy	$t_{D_X\ to\ Y}$	V_{IN0}=5V; V_{IN1}=5V; V_{SEn} =5V; V_{SEL1} = 0V; V_{SEL0} =0V to 5V; I_{OUT0}=0A; I_{OUT1}=3A; R_{SENSE}=1kΩ			20	µs

ELECTRICAL CHARACTERISTICS (Continued)

All typical values refer to VCC = 13 V; T_j = 25°C, unless otherwise specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
MultiSense transition delay from current sense to T_C sense	$t_{D_CS\ to\ TC}$	V_{IN0}=5V; V_{SEn} =5V; V_{SEL0}=0V; V_{SEL1}=0V to 5V; I_{OUT0}=1.5A; R_{SENSE} =1kΩ			20	µs
MultiSense transition delay from T_C sense to current sense	$t_{D_TC\ to\ CS}$	V_{IN0}=5V; V_{SEn} =5V; V_{SEL0}=0V; V_{SEL1}=5V to 0V; I_{OUT0}=1.5A; R_{SENSE} =1kΩ			20	µs
MultiSense transition delay from current sense to V_{CC} sense	$t_{D_CS\ to\ VCC}$	V_{IN1}=5V; V_{SEn}=5V; V_{SEL0}=5V; V_{SEL1}=0V to 5V; I_{OUT1}=1.5A; R_{SENSE}=1kΩ			20	µs
MultiSense transition delay from V_{CC} sense to current sense	$t_{D_VCC\ to\ CS}$	V_{IN1}=5V; V_{SEn}=5V; V_{SEL0}=5V; V_{SEL1}=5V to 0V; I_{OUT1}=1.5A; R_{SENSE}=1kΩ			20	µs
MultiSense transition delay from T_C sense to V_{CC} sense	$t_{D_TC\ to\ VCC}$	V_{CC}=13V; T_j =125°C; V_{SEn}=5V; V_{SEL0}=0V to 5V; V_{SEL1}=5V; R_{SENSE} =1kΩ			20	µs
MultiSense transition delay from V_{CC} sense to T_C sense	$t_{D_VCC\ to\ TC}$	V_{CC}=13V; T_j =125°C; V_{SEn}=5V; V_{SEL0}=5V to 0V; V_{SEL1}=5V; R_{SENSE} =1kΩ			20	µs
MultiSense transition delay from stable current sense on Chx to V_{SENSEH} on Chy	$t_{D_CS\ to\ VSENSEH}$	V_{IN0}=5V; V_{IN1}=0V; V_{SEn} =5V; V_{SEL1}=0V; V_{SEL0} =0V to 5V; I_{OUT0}=3A; V_{OUT1}=4V; R_{SENSE}=1kΩ			20	µs

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \times \theta_{JA}$. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D(MAX)} = (T_{J(MAX)}-T_A)/\theta_{JA}$.

Note 3:VCC sensing and Tc sensing are referred to GND potential.

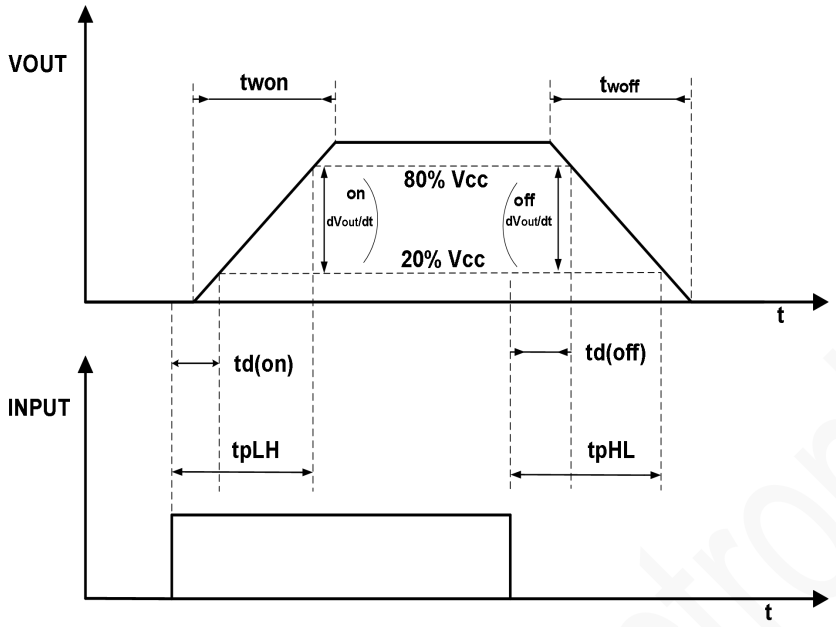


Figure 2: Switching time and Pulse skew

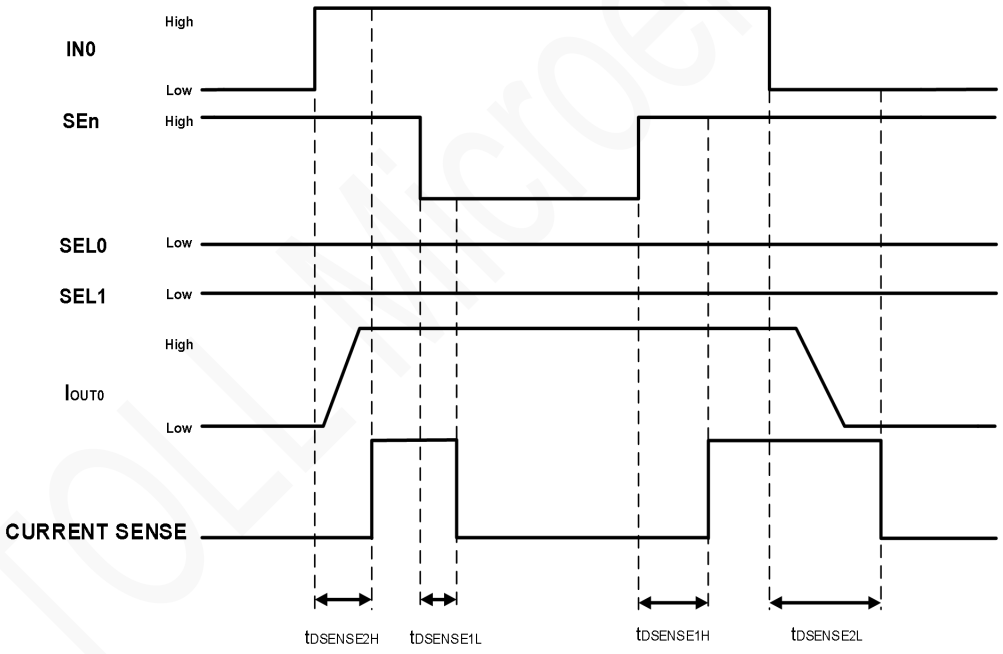


Figure 3: MultiSense timings (current sense mode)

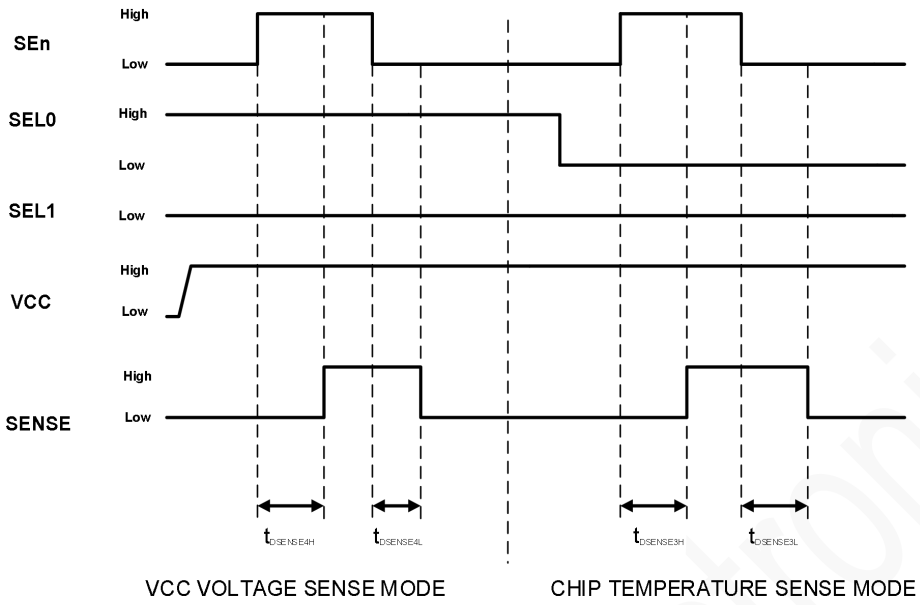


Figure 4: Multisense timings (chip temperature and VCC sense mode)

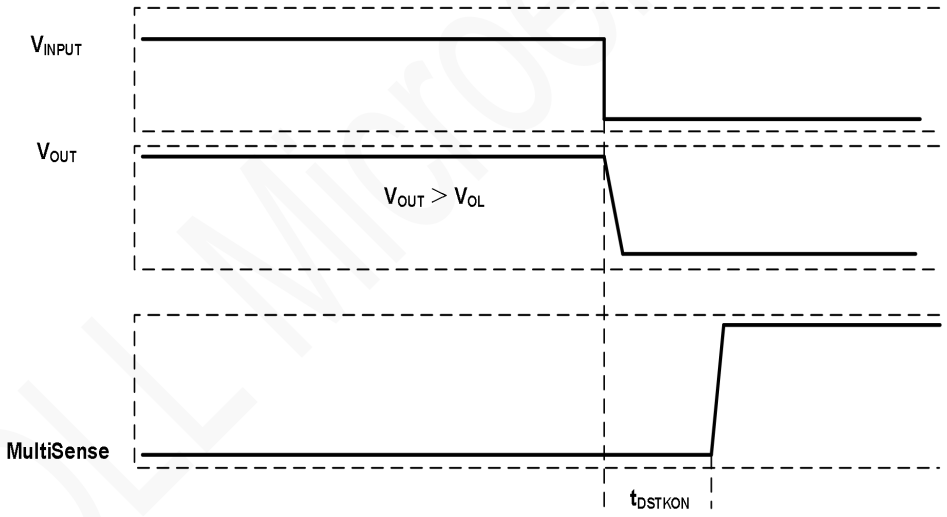


Figure 5: t_{DSTKON}

Typical Characteristics

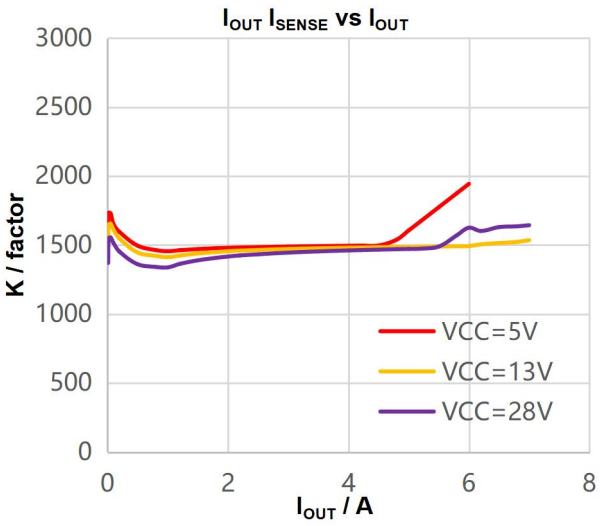


Figure 6. I_{OUT} I_{SENSE} vs I_{OUT}

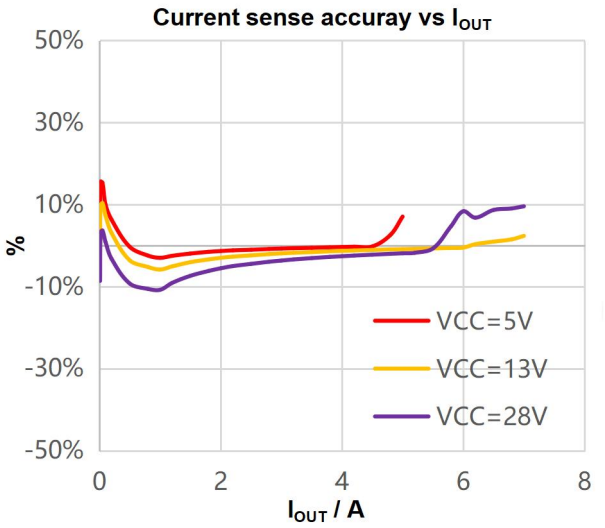


Figure 7. Current sense accuracy vs I_{OUT}

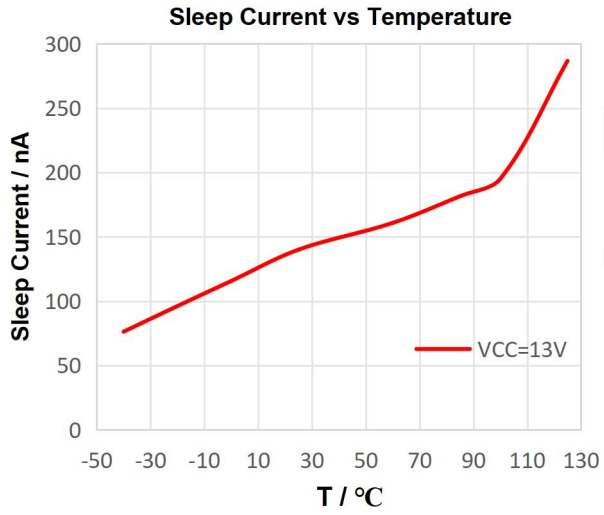


Figure 8. Sleep Current vs Temperature

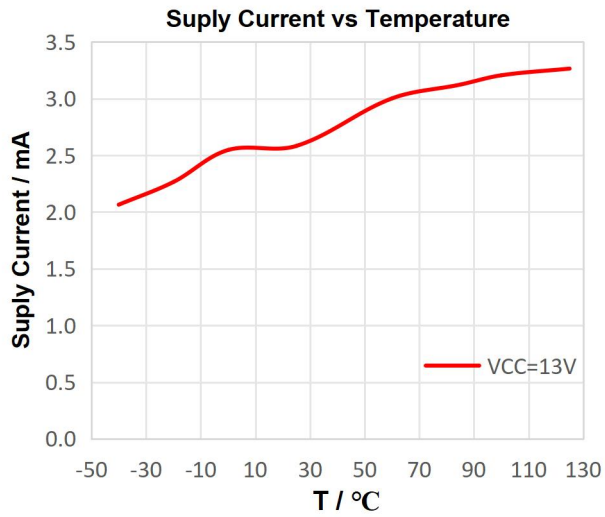


Figure 9. Supply Current vs Temperature

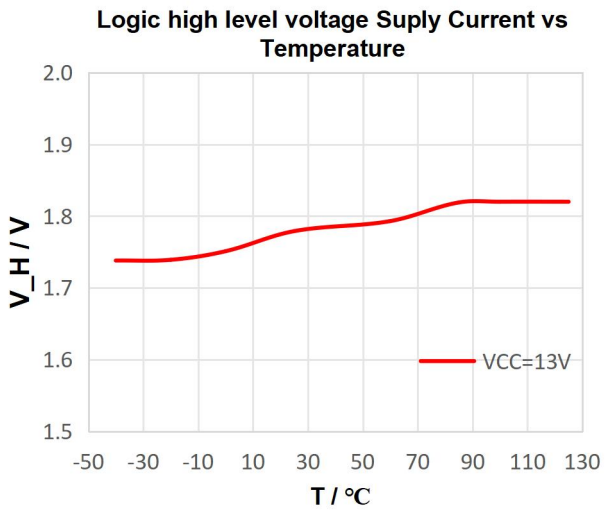


Figure 10. Logic high level voltage Suply Current vs Temperature

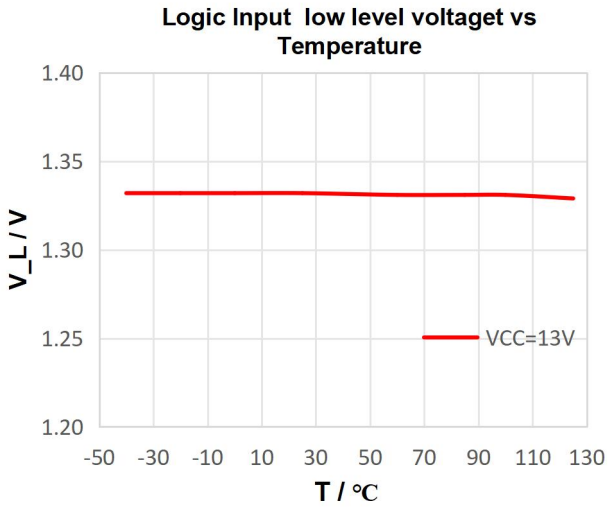


Figure 11. Logic Low level voltage Suply Current vs Temperature

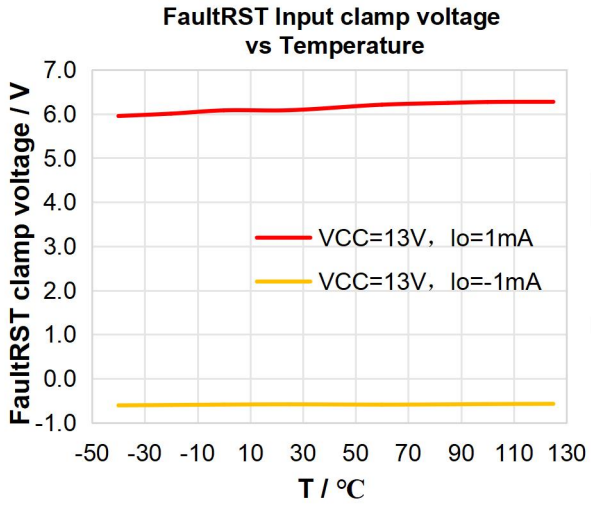


Figure 12.FaultRST Input clamp voltage vs Temperature

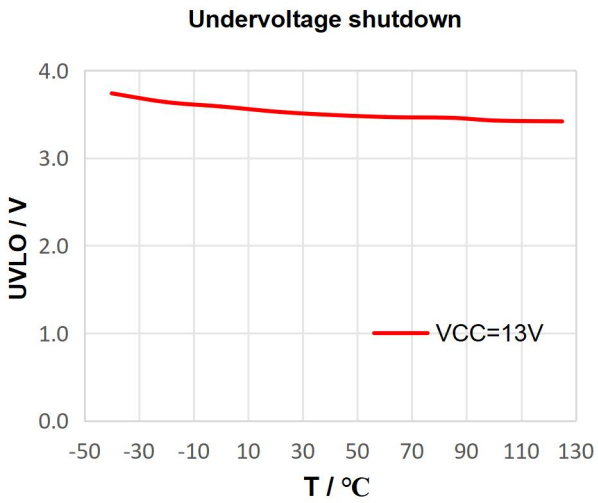


Figure 13.Undervoltage shutdown vs Temperature

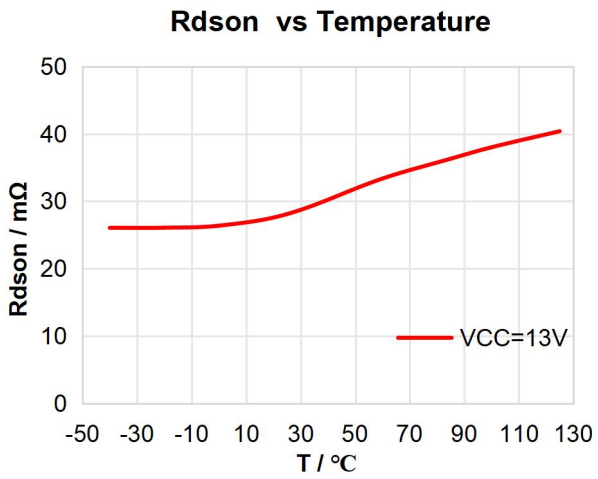


Figure 14.Rdson vs Temperature

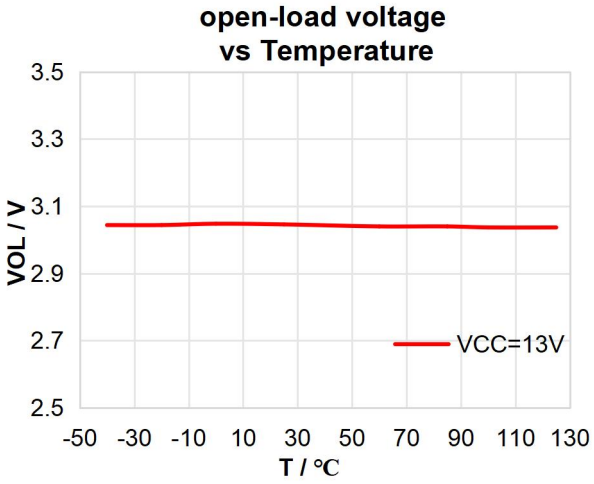


Figure 15.Open-load voltage vs Temperature

TOLL Microelectronic

OPERATION

Overview

The TMI82H05D-Q1 device is a smart high-side driver, with internal charge pump and dual-channel integrated NMOS power FETs. Full diagnostics and high-accuracy current-sense features enable intelligent control of the load. The adjustable current-limit function greatly improves the reliability of whole system.

The high-accuracy current sense makes the diagnostics more accurate without further calibration. One integrated current mirror can source 1/K of the load current. The mirrored current flows into the MultiSense pin resistor to become a voltage signal. A wide linear region from 0V to 6.0V allows a better real-time load-current monitoring. The MultiSense pin can also report a fault with pull up voltage of V_{SENSEH}.

The external high-accuracy current limit allows setting the current-limit value by applications. When overcurrent occurs, the device improves system reliability by clamping the inrush current effectively. The device can also save system cost by reducing the size of PCB traces and connectors, and the capacity of the preceding power stage. Besides, the device also implements an internal current limit with a fixed value.

For inductive loads (relays, solenoids, valves), the device implements an active clamp between drain and source to protect itself. During the inductive switching-off cycle, both the energy of the power supply and the load are dissipated on the high-side switch. The device also optimizes the switching-off slew rate when the clamp is active, which helps the system design by keeping the effects of transient power and EMI to a minimum.

Logical Functions

The truth tables for logic and output are shown in the following table.

Table 2: Truth table

Mode	Conditions	INX	FR	SEn	SELx	OUTx	MultiSense	Commemts
Standby	All Logic inputs low	L	L	L	L	L	Hi-Z	Low quiescent Current consumption
Normal	Nominal load connected; T_j < 125 °C	L	X	See(1)		L	See(1)	
		H	L			H		Outputs configured for auto-restart
		H	H			H		Outputs configured for Latch-off
Overload	Overload or short to GND causing: $T_j > T_{TSD}$ or $\Delta T_j > \Delta T_{j_SD}$	L	X	See(1)		L	See(1)	
		H	L			H		Output cycles with temperature hysteresis
		H	H			L		Output latches off

Table 2: Truth table(Continued)

Mode	Conditions	IN_X	FR	SEn	SELx	OUTx	MultiSense	Commemts
Undervoltage	$V_{CC} < V_{USD}$ (falling)	X	X	X	X	L	Hi-Z	Re-start when $V_{CC} > V_{USD} + V_{USDhyst}$ (rising)
OFF-state diagnostics	Short to V_{CC}	L	X	See(1)		H	See(1)	
	Open-load	L	X			H		External pull-up

Notes:

(1) Refer to **Table 3**: "MultiSense multiplexer addressing

Table 3: MultiSense multiplexer addressing

SEn	SEL1	SEL0	MUX channel	MultiSense output			
				Normal mode	Overload	OFF-state diag(1)	Negative output
L	X	X		Hi-Z			
H	L	L	Channel 0 diagnostic	I_{SENSE} = 1/K * I_{OUT0}	V_{SENSE} = V_{SENSEH}	V_{SENSE} = V_{SENSEH}	Hi-Z
H	L	H	Channel 1 diagnostic	I_{SENSE} = 1/K * I_{OUT1}	V_{SENSE} = V_{SENSEH}	V_{SENSE} = V_{SENSEH}	Hi-Z
H	H	L	T_{CHIP} Sense	$V_{SENSE} = V_{SENSE_TC}$			
H	H	H	V_{CC} Sense	$V_{SENSE} = V_{SENSE_VCC}$			

Notes:

(1) In case the output channel corresponding to the selected MUX channel is latched off while the relevant input is low, Multisense pin delivers feedback according to OFF-State diagnostic. Example 1: FR = 1; IN0 = 0; OUT0 = L (latched); MUX channel = channel 0 diagnostic; Mutisense = 0. Example 2: FR = 1; IN0 = 0; OUT0 = latched, $V_{OUT0} > V_{OL}$; MUX channel = channel 0 diagnostic; Mutisense = V_{SENSEH}.

Protections

Power Limitation

The basic working principle of this protection consists of an indirect measurement of the junction temperature swing ΔT_j through the direct measurement of the spatial temperature gradient on the device surface in order to automatically shut off the output MOSFET as soon as ΔT_j exceeds the safety level of ΔT_{j_SD}. According to the voltage level on the FaultRST pin, the output MOSFET switches on and cycles with a thermal hysteresis according to the maximum instantaneous power which can be handled (FaultRST = Low) or remains off (FaultRST = High). The protection prevents fast thermal transient effects and, consequently, reduces thermo-mechanical fatigue.

Thermal Shutdown

In case the junction temperature of the device exceeds the maximum allowed threshold (typically 175°C), it automatically switches off and the diagnostic indication is triggered. According to the voltage level on the FaultRST pin, the device switches on again as soon as its junction temperature drops to T_R (FaultRST = Low) or remains off (FaultRST = High).

Current Limitation

The device is equipped with an output current limiter in order to protect the silicon as well as the other components of the system (e.g. bonding wires, wiring harness, connectors, loads, etc.) from excessive current flow. Consequently, in case of short circuit, overload or during load power-up, the output current is clamped to a safety level, I_{LIMH}, by operating the output power MOSFET in the active region.

Diode (DGND) in the ground line

A resistor (typ. R_{GND} = 4.7kΩ) should be inserted in parallel to D_{GND} if the device drives an inductive load. This small signal diode can be safely shared amongst several different HSDs. Also in this case, the presence of the ground network produces a shift (≈600mV) in the input threshold and in the status output values if the microprocessor ground is not common to the device ground. This shift does not vary if more than one HSD shares the same diode/resistor network.

MCU I/Os Protection

If a ground protection network is used and negative transients are present on the VCC line, the control pins will be pulled negative. we suggests to insert a resistor (Rprot) in line both to prevent the microcontroller I/O pins from latching-up and to protect the HSD inputs.
The value of these resistors is a compromise between the leakage current of microcontroller and the current required by the HSD I/Os (Input levels compatibility) with the latch-up limit of microcontroller I/Os.

Equation

$V_{CCpeak}/I_{latchup} \le R_{prot} \le (V_{OH\mu C} - V_{IH} - V_{GND}) / I_{IHmax}$
Calculation example:
For V_{CCpeak} = -150 V; $I_{latchup} \ge$ 20 mA; $V_{OH\mu C} \ge$ 4.5 V
7.5 kΩ ≤ R_{prot} ≤ 140 kΩ.
Recommended values: R_{prot} = 15 kΩ

Multisense - analog current sense

Diagnostic information on device and load status are provided by an analog output pin (MultiSense) delivering the following signals:

(1) Current monitor: current mirror of channel output current .

(2) V_{CC} monitor: voltage propotional to VCC .

(3) T_{CASE}: voltage propotional to chip temperature .

Those signals are routed through an analog multiplexer which is configured and controlled by means of SELx and SEn pins, according to the address map in MultiSense multiplexer addressing Table.

Current monitor

When current mode is selected in the MultiSense, this output is capable to provide:

(1) Current mirror proportional to the load current in normal operation, delivering current proportional to the load according to known ratio named **K**

(2) Diagnostics flag in fault conditions delivering fixed voltage V_{SENSEH} .

The current delivered by the current sense circuit, I_{SENSE}, can be easily converted to a voltage V_{SENSE} by using an external sense resistor, R_{SENSE}, allowing continuous load monitoring and abnormal condition detection.

Normal operation (channel ON, no fault, SEn active)

While device is operating in normal conditions (no fault intervention), V_{SENSE} calculation can be done using simple equations.

Current provided by MultiSense output: $I_{SENSE} = I_{OUT}/K$.

Voltage on R_{SENSE}: $V_{SENSE} = R_{SENSE} \cdot I_{SENSE} = R_{SENSE} \cdot I_{OUT}/K$.

Where:

(1) V_{SENSE} is voltage measurable on R_{SENSE} resistor.

(2) I_{SENSE} is current provided from MultiSense pin in current output mode.

(3) I_{OUT} is current flowing through output.

(4) K factor represents the ratio between PowerMOS cells and SenseMOS cells; its spread includes geometric factor spread, current sense amplifier offset and process parameters spread of overall circuitry specifying ratio between I_{OUT} and I_{SENSE}.

Failure flag indication

In case of power limitation/overtemperature, the fault is indicated by the MultiSense pin which is switched to a “current limited” voltage source, V_{SENSEH}.

In any case, the current sourced by the MultiSense in this condition is limited to I_{SENSEH}.

The typical behavior in case of overload or hard short circuit is shown in Waveforms section.

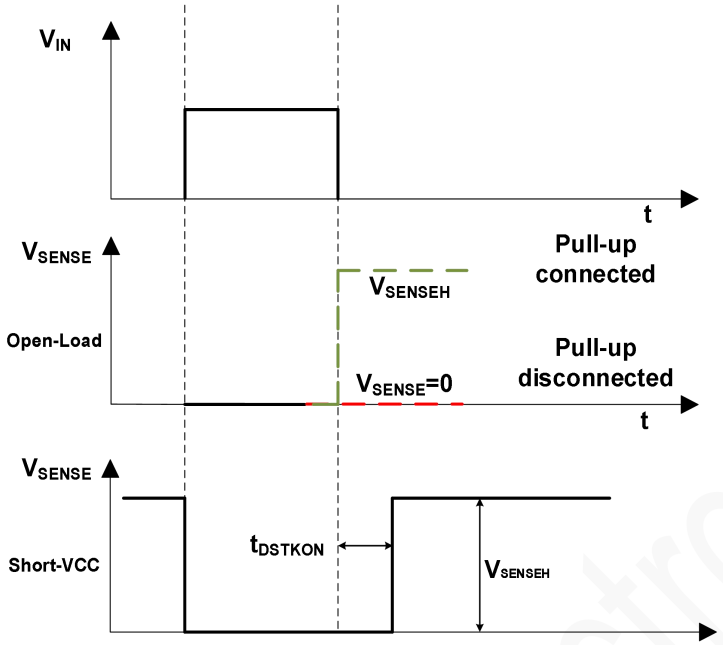


Figure 16.Open-load / short to VCC condition

Table 4: MultiSense pin levels in off-state

Condition	Output	MultiSense	SEn
Open-load	$V_{OUT} > V_{OL}$	Hi-Z	L
		V_{SENSEH}	H
	$V_{OUT} > V_O$	Hi-Z	L
		0	H
Short to VCC	$V_{OUT} > V_O$	Hi-Z	L
		V_{SENSEH}	H
Normal	$V_{OUT} > V_O$	Hi-Z	L
		0	H

TCASE and VCC monitor

In this case, MultiSense output operates in voltage mode and output level is referred to device GND.Care must be taken in case a GND network protection is used, because a voltage shift is generated between the device GND and the microcontroller input GND reference.

VCC monitor

Battery monitoring channel provides V_{SENSE} = VCC / 4.

Case temperature monitor

Case temperature monitor is capable of providing information about the actual device temperature. Since a diode is used for temperature sensing, the following equation describes the link between temperature and output V_{SENSE} level:
V_{SENSE_TC} (T) = V_{SENSE_TC} (T_0) + dV_{SENSE_TC} / dT * (T - T_0)
where dV_{SENSE_TC} / dT ~ typically -5.5 mV/K (for temperature range (-40 °C to 125 °C)).

Short to VCC and OFF-state open-load detection

Short to V_{CC}

A short circuit between VCC and output is indicated by the relevant current sense pin set to V_{SENSEH} during the device off-state. Small or no current is delivered by the current sense during the on-state depending on the nature of the short circuit.

OFF-state open-load with external circuitry

Detection of an open-load in off mode requires an external pull-up resistor R_{PU} connecting the output to a positive supply voltage V_{PU}.
It is preferable that V_{PU} is switched off during the module standby mode in order to avoid the overall standby current consumption to increase in normal conditions, i.e. when load is connected.
R_{PU} must be selected in order to ensure V_{OUT} > V_{OLmax} in accordance with the following

Equation:

$$R_{PU} < \frac{V_{PU} - 4}{I_{L(OFF2)min@4V}}$$

APPLICATION INFORMATION

Application information

The TMI82H05D-Q1 device is typically used to drive one brushed DC motor as below,or can be used as a high-side power switch for a wide variety of resistive, inductive and capacitive loads.

When drive capacitive loads, for example DC motor; it is recommended to add a flyback diode diodes between OUTx and GND.

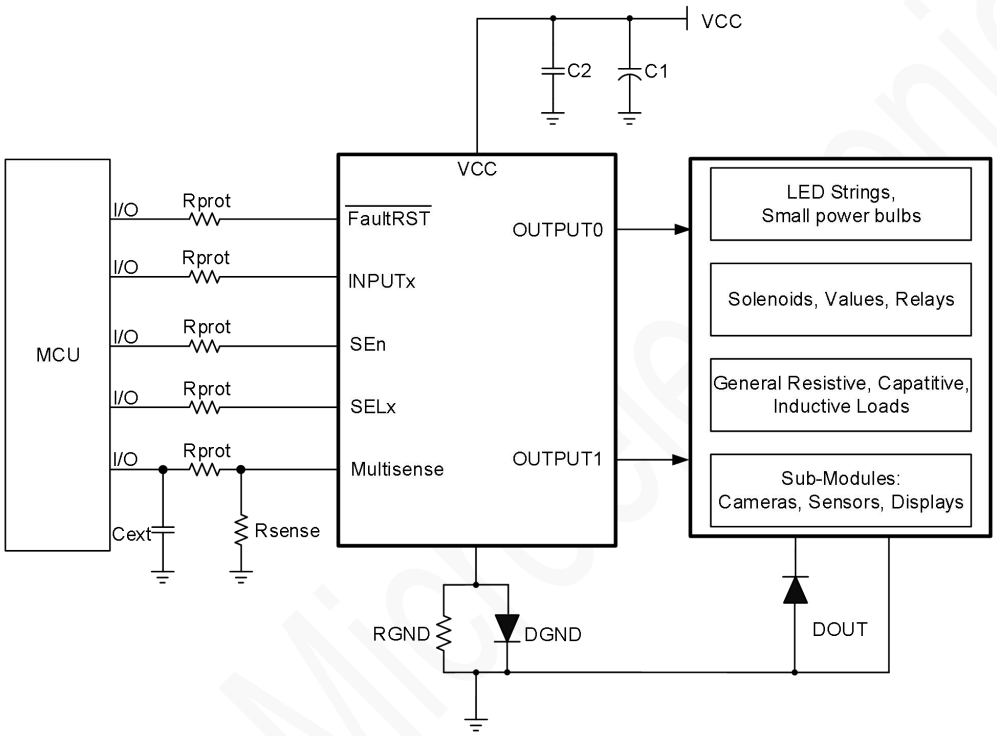


Figure 17. TMI82H05D-Q1 Typical Application

Block Diagram

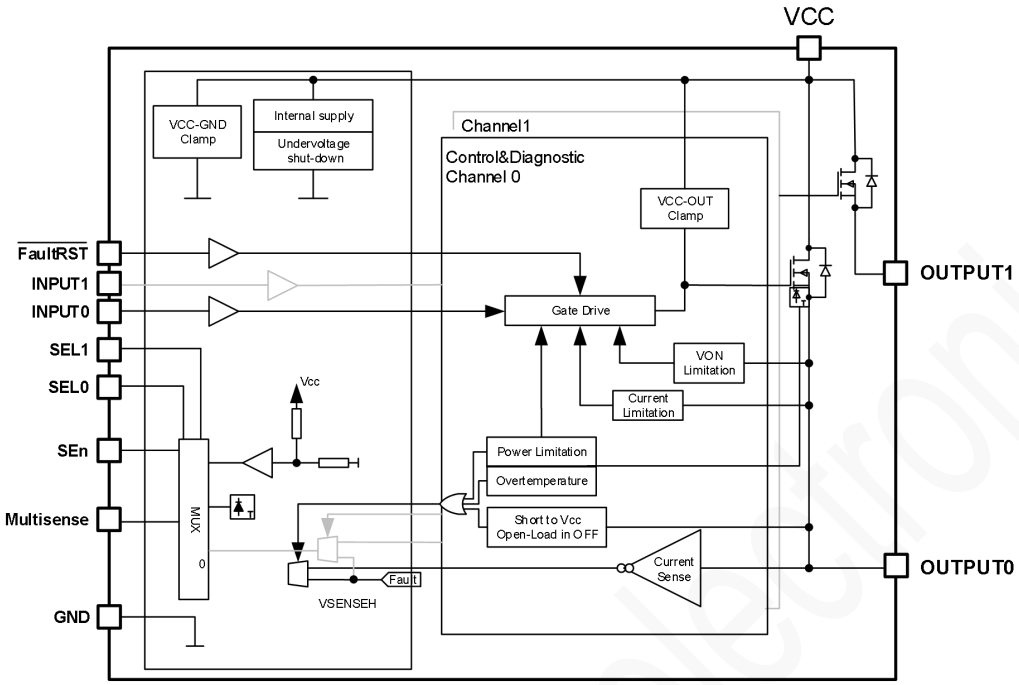


Figure 18. TMI82H05D-Q1 Block Diagram

Suggested PCB layout

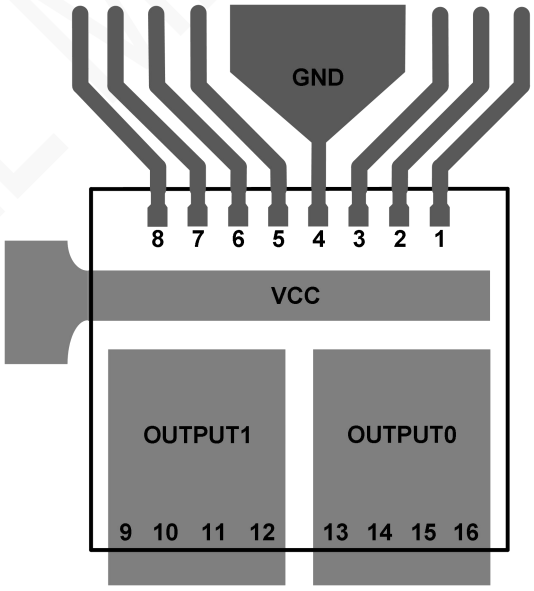


Figure 19. TMI82H05D-Q1 Simplified Layout Example

PCB Layout Guidelines

1. The bulk capacitor should be placed to minimize the distance of the high-current path through the motor driver device. The connecting metal trace widths should be as wide as possible, and numerous vias should be used when connecting PCB layers. These practices minimize inductance and allow the bulk capacitor to deliver high current.
2. Small-value capacitors should be ceramic, and placed closely to device pins.
3. The high-current device outputs should use wide metal traces.
4. The device thermal pad should be soldered to the PCB top-layer ground plane. Multiple vias should be used to connect to a large bottom-layer ground plane. The use of large metal planes and multiple vias help dissipate the I^2 x $R_{DS(on)}$ heat that is generated in the device.
5. The pin pad extends more than 0.4mm outwards as far as possible according to the POD size, which helps to connect the chip and pad during welding.

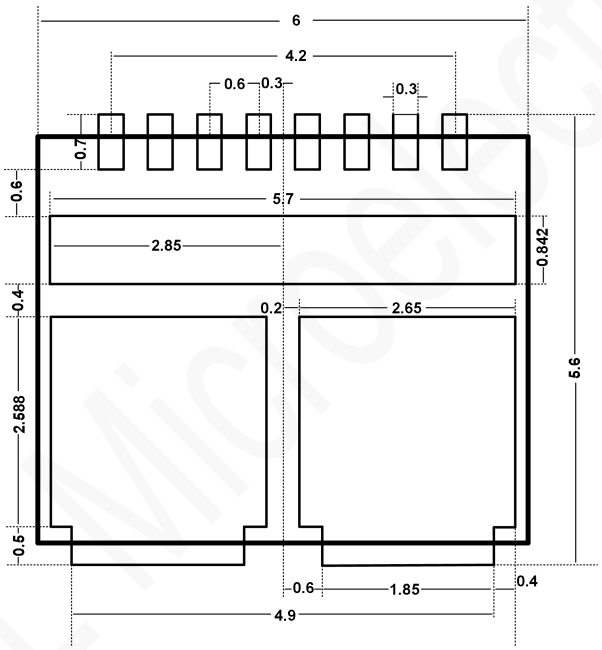
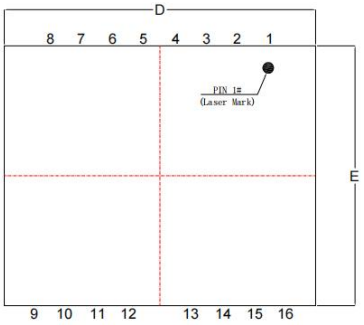


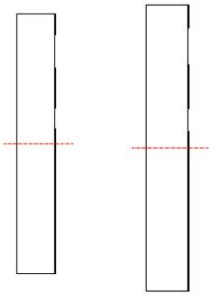
Figure 20. TMI82H05D-Q1 Recommended size of Pad

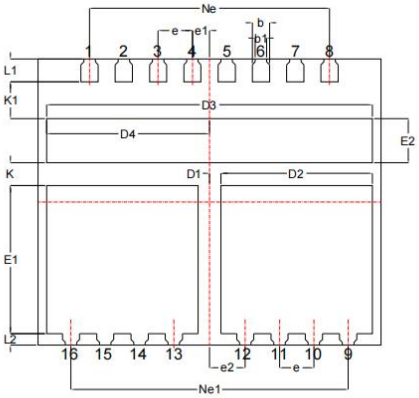
PACKAGE INFORMATION

DFN6X5-16

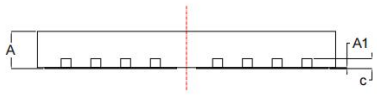


TOP VIEW





BOTTOM VIEW



SIDE VIEW

Unit: mm

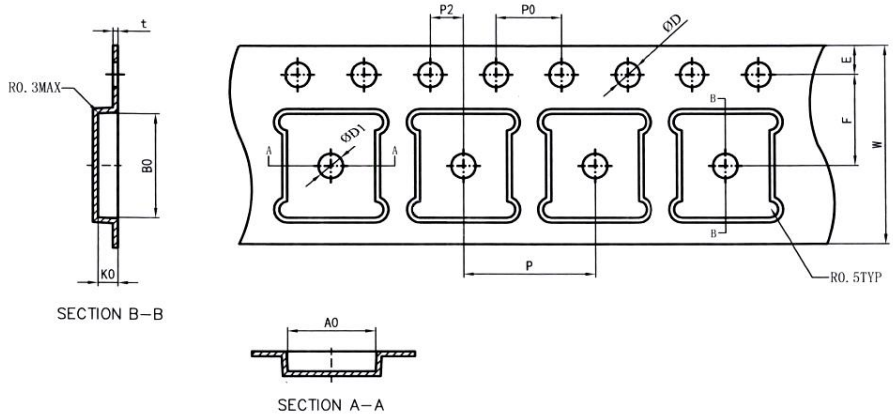
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	NOM	Max		Min	NOM	Max
A	0.70	0.75	0.8	L2	0.15	0.20	0.25
A1	0	0.02	0.05	e1	0.30BSC		
b	0.25	0.30	0.35	e2	0.625BSC		
b1	0.20REF			K	0.40REF		
c	0.203REF			K1	0.64REF		
D	5.90	6.00	6.10	D1	0.20REF		
E	4.90	5.00	5.10	D2	2.60	2.65	2.70
e	0.60BSC			D3	5.65	5.7	5.75
Ne	4.20BSC			D4	2.85REF		
Ne1	4.85BSC			E1	2.538	2.588	2.638
L1	0.35	0.40	0.45	E2	0.722	0.772	0.822

Note:

1) All dimensions are in millimeters.
2) Package length does not include mold flash, protrusion or gate burr.
3) Package width does not include inter lead flash or protrusion.
4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
5) Pin 1 is lower left pin when reading top mark from left to right.

TAPE AND REEL INFORMATION

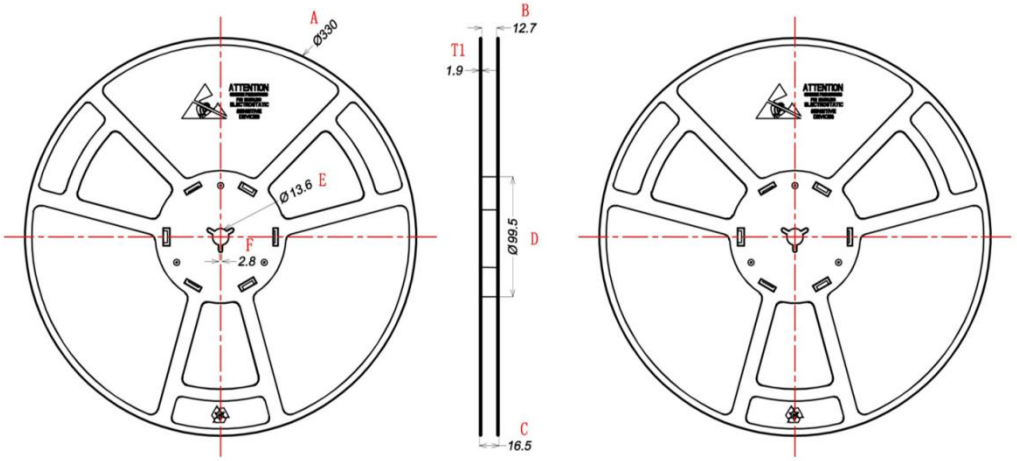
TAPE DIMENSIONS: DFN6X5-15



Unit: mm

E	F	P2	D	D1	P0	10P0
1.75±0.10	5.50±0.05	2.00±0.05	$1.50^{+0.10}_{0}$	1.50MIN	4.00±0.10	40.0±0.20
W	**P**	**A0**	**BO**	**K0**	**t**	
$12^{+0.20}_{-0.10}$	8.00±0.10	5.30±0.10	6.30±0.10	1.20±0.10	0.30±0.05	

REEL DIMENSIONS: DFN6X5-15



Unit: mm

A	B	C	D	E	F	T1
Ø 330±1	**12.7±0.5**	**16.5±0.3**	**Ø 99.5±0.5**	**Ø 13.6±0.2**	**2.8±0.2**	**1.9±0.2**

Note:

1) All Dimensions are in Millimeter
2) Quantity of Units per Reel is 5000
3) MSL level is level1.

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