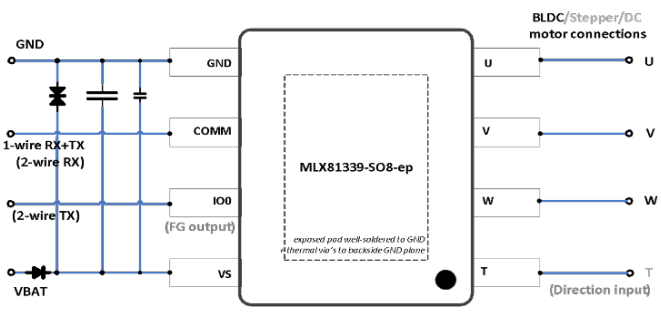
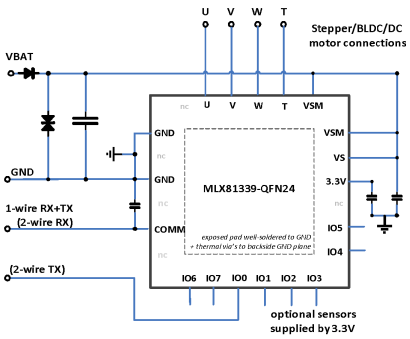
1. Features and Benefits

- Motor driver with 4 Half-bridges
  - Sensorless Driver for DC/BLDC/Stepper
    - FOC Sine Drive for BLDC or Stepper
  - Ron =0.35Ω typ. for 1 Half-bridge + Shunt
  - 2x NFET for each Half-bridge
  - on-chip charge-pump for top-NFETs
  - V_{ds} protection for all NFETs
- Control interface:
  - PWM, Analog, UART, I^2C, SPI
- Microcontroller:
  - MLX16-FX, application CPU
  - Memories:
    - 32 KB Flash, 2 KB RAM
    - 1 KB in Flash for IC and application configuration
    - 10KB ROM for EOL programming (PPM/UART), IC startup
- Package: QFN24, SO8-ep
- IC temperature range -40°C to 150°C (ambient temperature: -40°C to 125°C)
- AEC-Q100 qualified
- Periphery
  - RC-clock 24, 28, 32 & 36 MHz
  - 8x general purpose IO's, digital, analog, UART, SPI, I^2C-slave
  - 5x 16-bit motor PWM timer, 2x 16-bit timers, 1x 14-bit timer
  - 13-bit ADC with < 2 µs update rate for differential current, 12-bit for voltage, temperature channels
  - Differential Current sensing +/-4A
  - Temperature sensor, over-temperature protection
  - Over-current, over-voltage and under-voltage protection
- Voltage regulators
  - Internal voltage regulators, powered from 24V or 12V supply
  - Motor operating supply Vs = 5.5V to 26V
  - MCU active down to 4V; down to 1.5V with intact RAM memory
  - Low standby current consumption of typ. 25µA in sleep mode
  - Wake-up via COMM interface (PWM, I2C, UART), IO0, internal wake-up timer

2. Application Example





- Sensorless Stepper or BLDC fan, pump, valve, flap, up to 1.6A (0.35Ω Ron)
- Sensorless DC or 1-phase fan, pump, valve, flap, up to 2.5A (0.18Ω Ron)

- Application customer configuration via MLX-Start-to-Run tool, option for preprogrammed SW

3. Ordering Information

Order Code	Temp. Range	Package	Delivery	Remark
MLX81339 KLW-BMX-202-RE	-40 - 125 °C	QFN24_WF 4x4	Reel	BLDC/Stepper/DC, 8x IO, Serial/I2C/SPI
MLX81339 KDC-BMX-202-RE	-40 - 125 °C	SO8-ep	Reel	MLX Codefree demo samples

Table 1 – Ordering information

4. Family Concept

	MLX81339	MLX81348 (48V)	MLX81349 (48V)
MCU Memory	**32 KB Flash + 10 KB ROM**	64 KB Flash + 10 KB ROM	32 KB Flash + 10 KB ROM
MCU NVRAM	**8x 128 Byte**	8x 128 Byte	8x 128 Byte
MCU RAM	**2 KB**	4 KB	2 KB
Coprocessor + 3kB RAM	**Yes**	Yes	Yes
Operating voltage (motor power)	**5.5V..26V (<40W)**	8V..80V (<1500W)	8V..80V (<150W)
Driver	**4x Driver on-chip typ. 0.35Ω Halfbridge**	3x PreDriver for 100nC FETs	3x PreDriver for 20nC FETs
IO pins (analog, digital)	**8x LV (1x HV)**	14x LV (1x HV)	4x LV (1x HV)
Motor current sense	**Low side, On-chip**	1..3x Low side, External shunt(s)	Low side, External shunt
ADC for motor current, voltage, external sensors	**13-bit differential 2µs update rate**	13-bit differential 2µs update rate	13-bit differential 2µs update rate
Sensor interface (3V/5V supply)	**analog, pwm, spi, sent, I²C, uart, AB encoder**	analog, pwm, spi, sent, I²C, uart, AB encoder	analog, pwm, spi, sent, I²C, uart, AB encoder
Sensorless support (hw + sw)	**Yes**	Yes	Yes
Maximum IC Temperature (with validated mission profile)	**T_j = 150°C**	Tj = 150°C	Tj = 150°C
Package	**QFN24, 4x4 SO8-ep**	QFN32, 5x5	QFN24, 4x4

Table 2 – Family Overview

5. Revision history

Version	Date	Description
001	23/09/2025	released product abstract after review

Table 3 – Revision history

6. Contents

7. Abbreviations

ADC	Analog Digital converter
API	Application Program Interface
ASSP	Application Specific Standard Product
CPU	Central Processing Unit
CRC	Cyclic Redundancy Code
DMA	Direct Memory Access
EEPROM	Electrically Erasable/Programmable Read-Only Memories, implemented in Configuration FLASH
ECC	Error Correction Code
ECU	Electronic Control Unit (with µ-Controller/µ-Processor)
HV	High Voltage Pin
IC	Integrated Circuit
ID	Identifier
IO	Input Output
IP	Intellectual Property
LSB	Least Significant Bit
LV	Low Voltage Pin
NB	Narrow Body
MCU	Microcontroller Unit
MSB	Most Significant Bit
OSI	Open Systems Interconnection Model
PHY	Physical Layer
PPM	Pulse Position Modulation (physical layer for fast Flash programming)
PWM	Pulse Width Modulator
RAM	Random Access Memory
ROM	Read Only Memory
SMD	Surface Mount Device
TBD	To Be Defined

8. References

Following documents are referred to in this document:

[1] MLX81339/49 Application Note

9. IC Block diagram

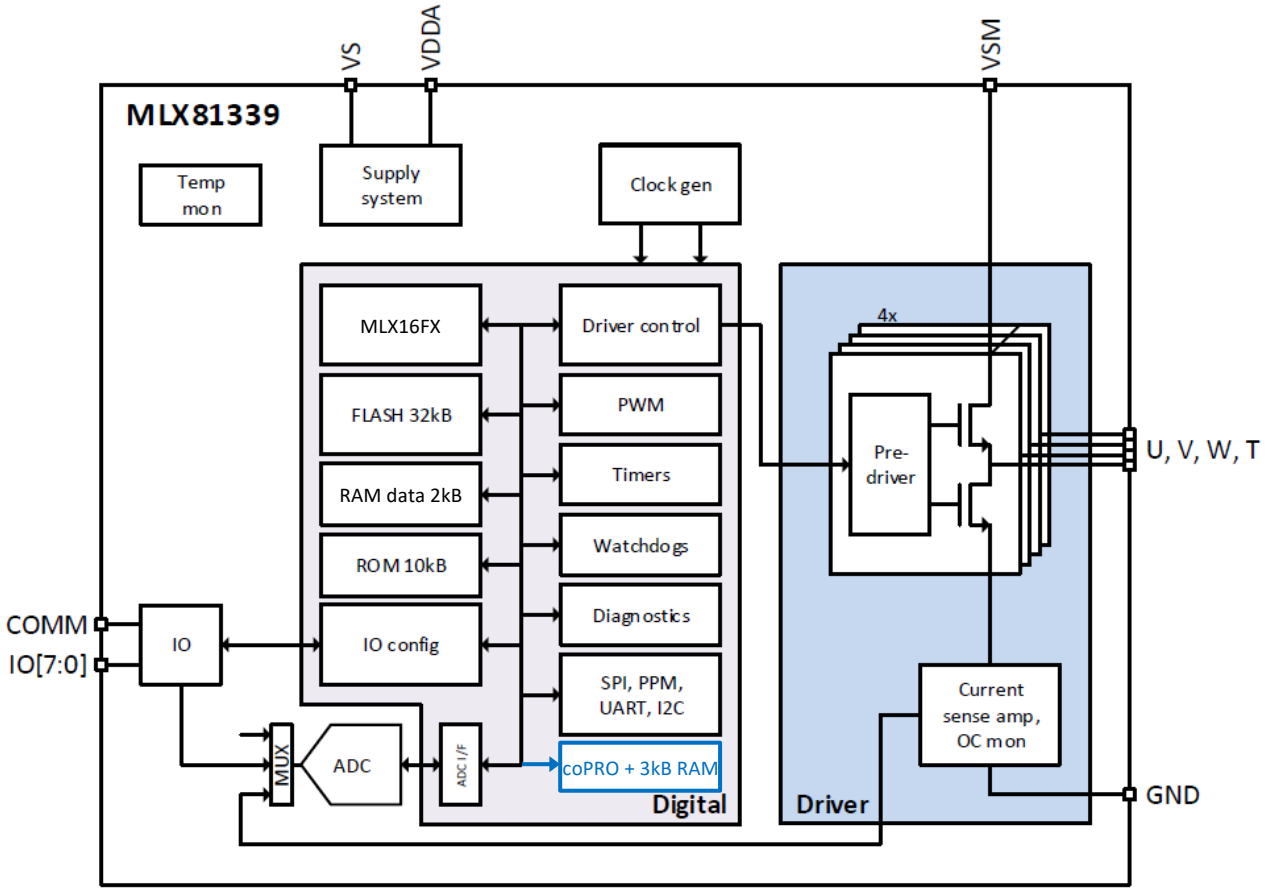
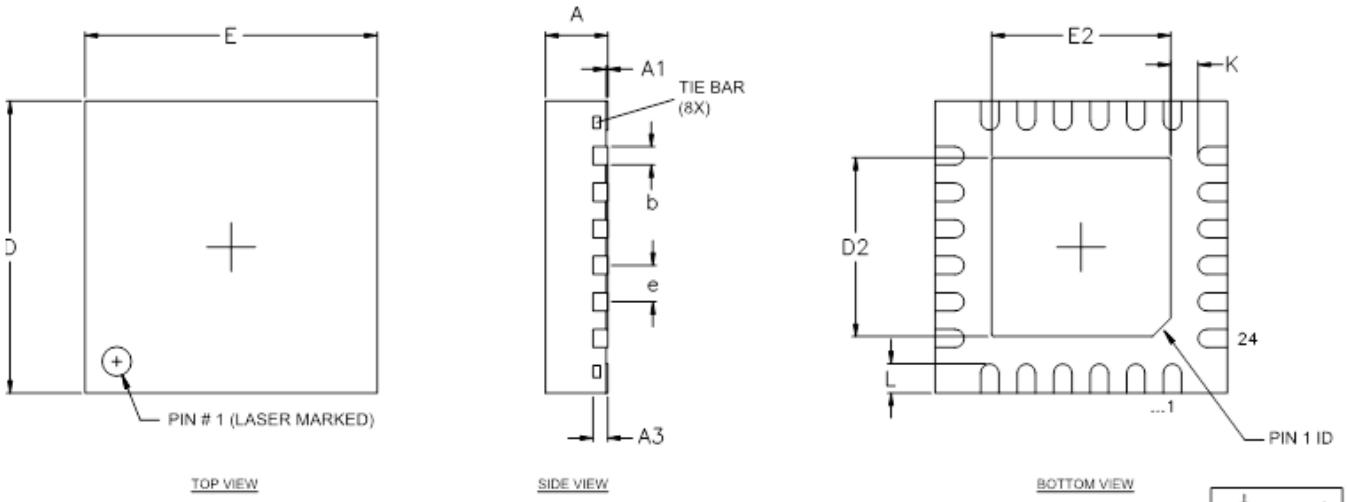


Figure 1 – IC Block diagram

10. Technical description

10.1. Package data QFN24

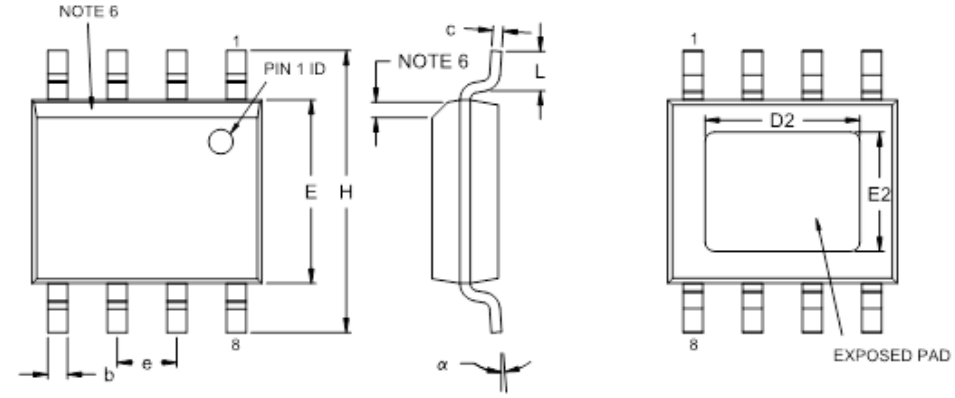


SYMBOL	ALL DIMENSION ARE IN MILLIMETERS		
	MINIMUM	NOMINAL	MAXIMUM
A	0.80	0.85	1.00
A1	0.00	0.02	0.05
A3		0.20 REF	
D	3.90	4.00	4.10
E	3.90	4.00	4.10
D2	2.35	2.45	2.55
E2	2.35	2.45	2.55
L	0.30	0.40	0.50
K	0.20	---	---
b	0.18	0.25	0.30
e		0.50 BSC	

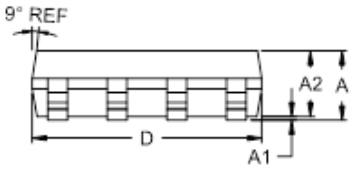
NOTE :
1. EXPOSED TIE BAR SHOULD BE KEPT FREE FROM SOLDER.
2. (OPTIONAL) SIDE WALL IMMERSION TIN PLATING MIN 1um THICK.

Figure 2 – Package data QFN24

10.2. Package data SO8-ep



SYMBOL	MINIMUM	NOMINAL	MAXIMUM
A	1.40	---	1.68
A1	0.00	---	0.13
A2	1.37	---	1.58
D	4.80	4.90	5.00
E	3.81	3.90	3.99
D2	3.00	3.30	3.55
E2	2.29	2.50	2.79
H	5.80	6.00	6.20
L	0.41	---	1.27
b	0.36	0.41	0.46
c	0.19	---	0.25
e		1.27 BSC	
α	0°	---	8°



NOTE :
1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS OTHERWISE STATED.
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS OF MAX 0.15 mm PER SIDE.
3. DIMENSION E DOES NOT INCLUDE INTERLEADS FLASH OR PROTRUSIONS OF MAX 0.25 mm PER SIDE.
4. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION OF MAX 0.10 mm.
5. LEAD TO LEAD COPLANARITY MAX 0.100 mm.
6. MOLD CHAMFER ANGLE CAN DIFFER. DEPENDING ON MOLD TOOLING IT IS POSSIBLE TO HAVE NO CHAMFER OR A 45 DEGREE CHAMFER WITH TYPICAL WIDTH OF 0.33 mm. CONTACT MELEXIS IN CASE OF QUESTIONS.
7. DAMBAR CUT PORTION AT THE LEAD SHOULDER CAN HAVE TRACES OF EXPOSED COPPER. CONTACT MELEXIS IN CASE OF QUESTIONS.

Figure 3 – Package Drawing SOIC8 with exposed pad

10.3. Package pin-out

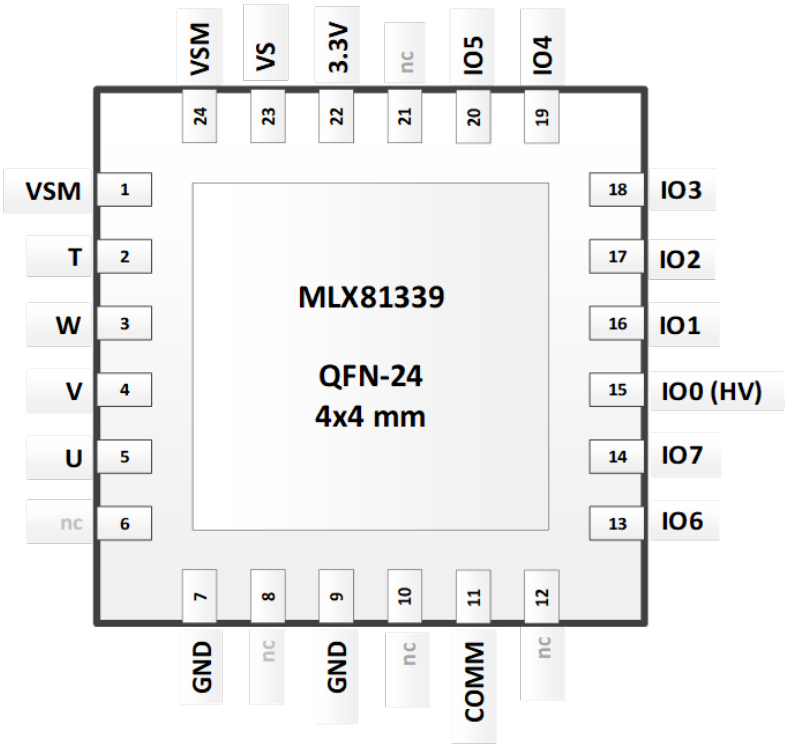


Figure 4 – Pin-out diagram QFN24 (-2xx variant)

The QFN24 variant is intended for flexible customer software programming or when external sensors are needed. The lower-priced SO8-ep variant is targeted for simpler high-volume motor applications with preprogrammed application software, which can be configured with the Melexis Start-to-Run tool for the customer's motor.

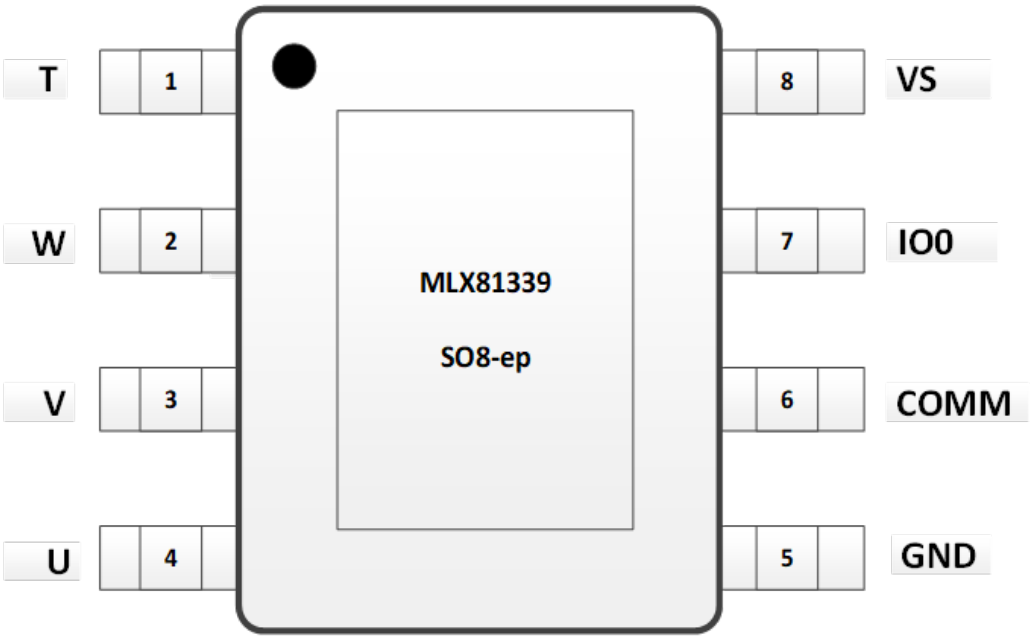


Figure 5 – Pin-out diagram SO8-ep (-2xx variant)

#	Pin name	Description	Comment
QFN24, 4x4mm		**All pins accessible**	**-2xx variant**
1	VSM	Supply voltage for motor driver	
2	T	T-phase	
3	W	W-phase	
4	V	V-phase	
5	U	U-phase	
6	nc		
7	GND	Ground	
8	nc		
9	GND	Ground	
10	nc		
11	COMM	Communication input/output	Used for UART RX+TX, I2C-SCL, PWM, Analog
12	nc		
13	IO6	LVIO	(also used for sw debug)
14	IO7	LVIO	(also used for sw debug)
15	IO0	LVIO + HVI (high-voltage input)	Used for UART TX, I2C-SDA
16	IO1	LVIO	
17	IO2	LVIO	
18	IO3	LVIO	
19	IO4	LVIO	
20	IO5	LVIO	
21	nc		
22	VDDA	3.3V analog supply voltage	
23	VS	Supply voltage for MCU	
24	VSM	Supply voltage for motor driver	

Table 4 – Pin-out description for QFN24

SO8-ep		8-pins accessible	-2xx variant (DC/BLDC/Stepper, 1x IO)
1	T	T-phase	
2	W	W-phase	
3	V	V-phase	
4	U	U-phase	
5	GND	Ground	
6	COMM	Communication input/output	Used for UART RX+TX, I2C-SCL, PWM, Analog
7	IO0	LVIO + HVI (high-voltage input)	Used for UART TX, I2C-SDA, sensor input
8	VS	Supply voltage (MCU + Driver)	

Table 5 – Pin-out description for SO8-ep, -2xx variant

10.4. Package Marking

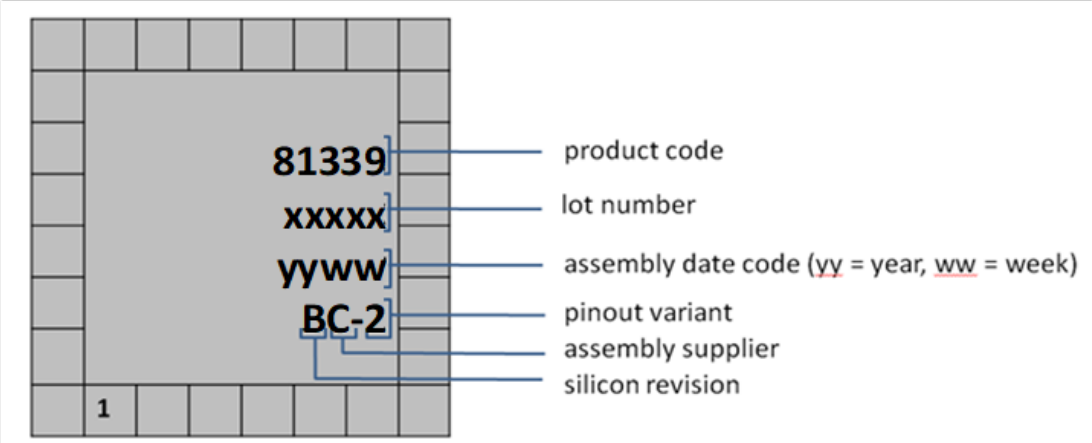


Figure 6 – Package Marking QFN24

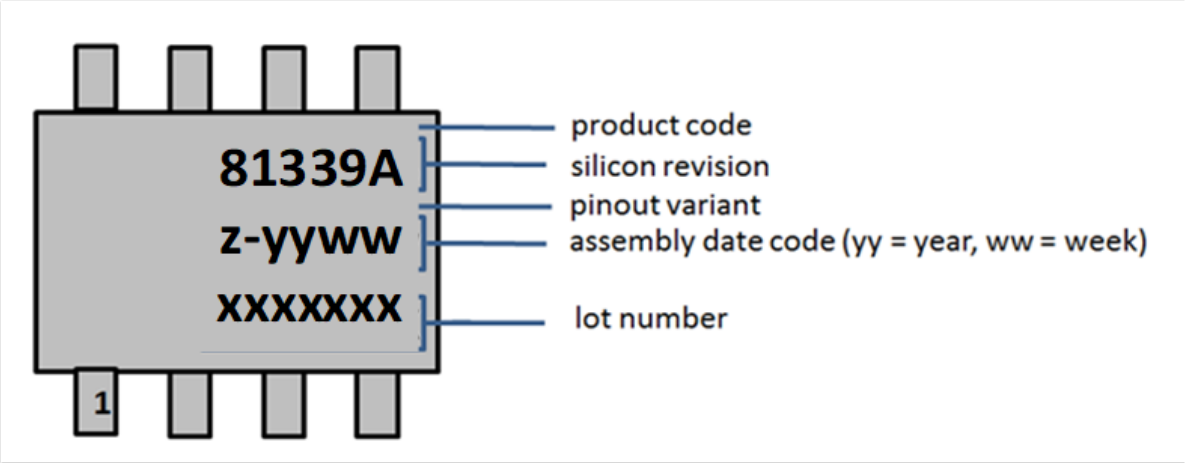


Figure 7 – Package Marking SOIC8-EP

11. Typical application schematic

In the following schematic examples, external components are indicated that may be needed to protect the IC against EMC / ESD pulses. Depending on ECU conditioned power, overvoltage and reverse polarity discretes may not be needed. Capacitor discretes or capacitor values will depend on specific OEM ESD/EMC requirements

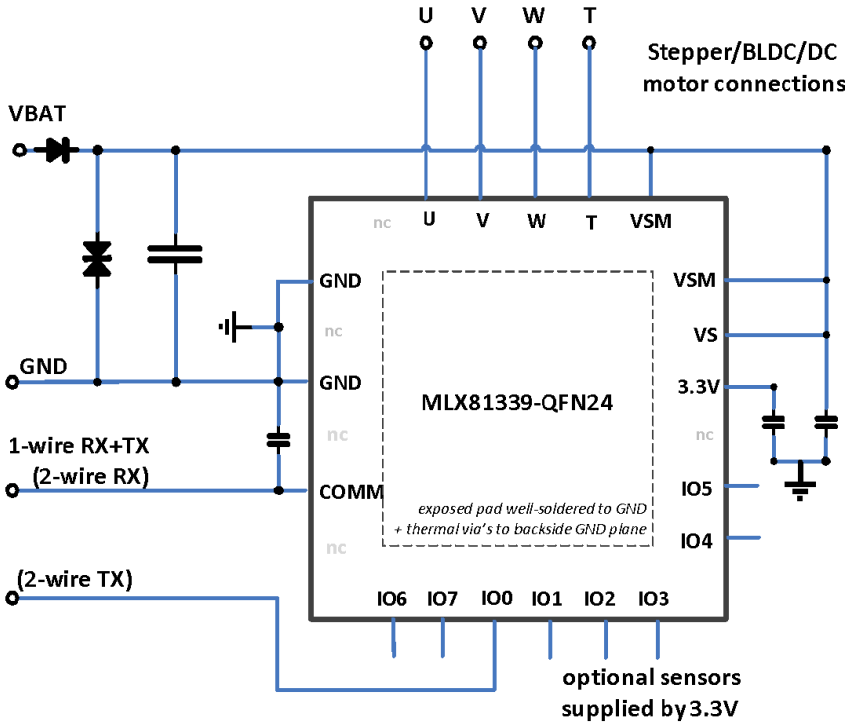


Figure 8 – Typical motor schematic with MLX81339 in QFN24

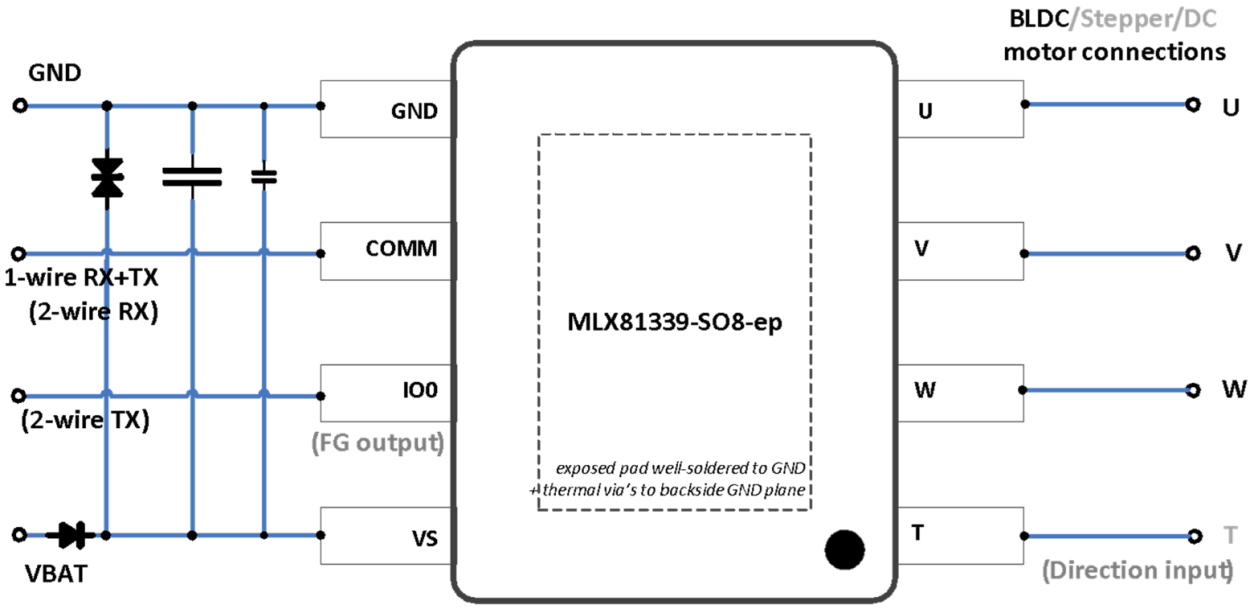


Figure 9 – Typical motor schematic with MLX81339 in SO8-ep

12. Electrical characteristics

12.1. Absolute maximum ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage	VS, VSM	-0.3		28	V	
Supply voltage transient	VS.tr1	-100			V	ISO 7637-2 pulse 1 [1]
Supply voltage transient	VS.tr2			75	V	ISO 7637-2 pulse 2 [1]
Supply voltage transient	VS.tr3	-150		100	V	ISO 7637-2 pulses 3a, 3b [1]
Output voltage 3.3V	VDDA	-0.3		3.6	V	3.3V IO option
Output voltage 5V	VDDA	-0.3		5.5	V	5V IO option
COMM	VCOMM	-0.3		VS+0.3	V	Referenced to GND
IO0 voltage	V_HVIO0	-0.3		VS+0.3	V	
HV phase voltage	VAN_HV	-0.3		VSM+0.3	V	U, V, W, T driver phases
Analog LV voltage	VAN_LV	-0.3		VDDA+0.3	V	IO0...7
Digital input voltage	VIN_DIG	-0.3		VDDA+0.3	V	IO0…7
Digital output voltage	VOUT_DIG	-0.3		VDDA+0.3	V	IO0...7
ESD HBM capability	ESD_HBM	-2		2	kV	All pins
ESD CDM capability	ESD_CDM	-500		500	V	All pins
Junction temperature	TJ	-40		150	ºC	

Table 6 – Absolute maximum ratings

[1] ISO 7637 test pulses are applied to VS via a reverse polarity diode, a TVS and a blocking capacitor.

12.2. Operating range

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage	V_S	6.5		26	V	Driver full performance
Supply voltage	V_S	5.5		6.5	V	Driver reduced performance [1]
Supply voltage	V_S	4		26	V	Analog + Digital full performance
Supply voltage	V_S	1.5		26	V	SRAM content valid
Junction temperature	T_J	-40		150	ºC	Limited time at Tj=150 ºC [2]

Table 7 – Operating range

[1] Motor driver is functional at reduced performance (higher bridge resistance, reduced accuracy of current sense amplifier) [2] Extended temperature range with Tj=150 ºC is only allowed for a limited time, customer's mission profile has to be agreed by Melexis as an obligatory part of the Part Submission Warrant (PSW).

12.4. Electrical specifications

12.4.1. Current consumption

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Normal working current	INOM		10		mA	Without coPRO active
Sleep mode current	ISLEEP		25		µA	VS=13V
Stop mode current	ISTOP		250		µA	
Holding current	IHOLD		5		mA	

Table 8 – Electrical specifications: current consumption

12.4.2. Supply system

12.4.2.1. VDDA 3.3V regulator (5V option, external C: 0 … 220nF)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
3.3V analog supply voltage (default)	VDDA	3.2	3.3	3.4	V	Bandgap and VDDA regulator trimmed
3.3V external current capability	IVDDA_EXT	0		15	mA	VS >= 4V
3.3V under-voltage detection threshold	VTH_UV_VDDA	2.75	2.85	2.95	V	VDDA ramping down
3.3V under-voltage detection hysteresis	VHY_UV_VDDA		0.1		V	
5V option (SWITCH_VDDA_TO_5V=1)						
5V analog supply voltage (option)	VDDA	4.75	5	5.25	V	Bandgap and VDDA regulator trimmed
5V external current capability	IVDDA_EXT	0		15	mA	VS >= 6V
5V under-voltage detection threshold	VTH_UV_VDDA	3.95	4.1	4.25	V	VDDA ramping down
5V under-voltage detection hysteresis	VHY_UV_VDDA		0.1		V	

Table 9 – Electrical specifications: VDDA regulator

12.4.2.2. VSM under-voltage and over-voltage detection

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
VSM under-voltage detection threshold	VTH_UV_VS	3.5	4	4.5	V	PRUV_VS=0
VSM under-voltage detection threshold	VTH_UV_VS	4.5	5	5.5	V	PRUV_VS=1
VSM under-voltage detection threshold	VTH_UV_VS	5.5	6	6.5	V	PRUV_VS=2
VSM under-voltage detection threshold	VTH_UV_VS	6.5	7	7.5	V	PRUV_VS=3
VSM under-voltage detection threshold	VTH_UV_VS	7.5	8	8.5	V	PRUV_VS=4
VSM under-voltage detection threshold	VTH_UV_VS	8.5	9	9.5	V	PRUV_VS=5
VSM under-voltage detection hysteresis	VHY_UV_VS	0.1	0.5	1	V	
VSM over-voltage detection threshold	VTH_OV_VS	20	22	24	V	PROV_VS=0
VSM over-voltage detection threshold	VTH_OV_VS	22	24	26	V	PROV_VS=1
VSM over-voltage detection threshold	VTH_OV_VS	26	28	30	V	PROV_VS=2
VSM over-voltage detection hysteresis	VHY_OV_VS	0.5	1	2	V	

Table 10 – Electrical specifications: VS over- and under-voltage detection

12.4.2.3. Wake-up circuit

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Wake-up filter time IO pins	TFILT_WU_IO	15		80	µs	
Wake-up filter time COMM pin	TFILT_WU_COM	15		80	µs	
Wake-up time internal timer	TWU_INT		n/a			WUI=00 (no wake-up)
Wake-up time internal timer	TWU_INT		4096 / FOSC_10K			WUI=01 (~0.4 s)
Wake-up time internal timer	TWU_INT		8192 / FOSC_10K			WUI=10 (~0.8 s)
Wake-up time internal timer	TWU_INT		16384 / FOSC_10K			WUI=11 (~1.6 s)

Table 11 – Electrical specifications: wake-up circuit

12.4.3. Clock generation

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency 1MHz oscillator	FOSC_1M		1		MHz	Trimmed
Frequency 32MHz oscillator	FOSC_32M		32		MHz	Trimmed
Frequency 10kHz oscillator	FOSC_10K	5	10	20	kHz	
Timing accuracy	TIMING_ACC	-1.5%		1.5%	%	Timing accuracy after sw correction using Flash config calibration values

Table 12 – Electrical specifications: clock generation

12.4.4. Motor driver module

12.4.4.1. Charge Pump clock

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Charge pump clock frequency	FOSC_CP	57	60	63	MHz	Trimmed

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Charge pump clock frequency	FOSC_CP	79.3	83.5	87.7	MHz	Trimmed (default)

Table 13 – Electrical specifications: driver clock

12.4.4.2. Output stage

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Half-bridge phase current	IHB			2.3	A_{pk}	During normal operation
Half-bridge phase current	IHB			1.6	A_{rms}	During normal operation
Half-bridge resistance	RHB		0.35		Ω	TopFET + BottomFet + Shunt
Duty cycle range of PWM output	DC_OUT	2		98	%	For switching PWM (0% or 100% can be set as well) PWM frequency = 20kHz
Duty cycle of PWM output	DC_OUT	1		3	%	PWM duty cycle setting = 2% PWM frequency = 20kHz
Duty cycle of PWM output	DC_OUT	97		99	%	PWM duty cycle setting = 98% PWM frequency = 20kHz
FET over-current detection threshold	ITH_DS_HS	3.0	3.9	4.8	A	
FET over-current detection hysteresis	IHY_DS		0.1		A	

Table 14 – Electrical specifications: output stage

12.4.4.3. Current sense amplifier

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Sense resistor	RCS		0.035		Ω	
Input range	ICS	-4		4	A	Current sensing range, ~1mA/LSB
Over-current detection threshold	ITH_OC	0		4	A	Adjustable through 8bit DAC
Over-current detection threshold accuracy	ITH_OC	-10		10	%	OCD threshold = 2A

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Over-current settling time	TSET_TH_OC			10	µs	Settling time after adjustment
Gain	GCS	0.355	0.375	0.395	V/A	Trimmed and calibrated
Offset	VCSO	-25	0	25	mV	Trimmed and calibrated

Table 15 – Electrical specifications: current sense amplifier

12.4.5. VSM supply sensor

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Voltage range for ADC measurement				28	V	Measurement of VSM/18
VSM filter cut-off frequency				4	kHz	

Table 16 – Electrical specifications: VSM supply sensor

12.4.6. Over-temperature detection

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
OTD threshold	TTH_OT	145	155	165	ºC	Temperature ramping up
OTD threshold	TTH_OT	120	130	140	ºC	Temperature ramping down
OTD hysteresis	THY_OT	10	25		ºC	

Table 17 – Electrical specifications: over-temperature detection

12.4.7. ADC

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Reference voltage	VREF_ADC		1.65		V	Trimmed and calibrated
Resolution			13		bit	13-bit differential input, includes 1-bit for sign
Sample & Hold time				1	µs	
Conversion time	TCONV			1.2	µs	
DNL		-1		1	LSB	
INL		-3		3	LSB	
IO1…IO7 ADC channel accuracy - 3.3V LV channels with 1/2.2 divider		-30		30	mV	0V – 3.3V input, calibrated acc. calibration document
IO0, COMM ADC channel accuracy - 3.3V LV channels with 1/2.2 divider		-45		45	mV	0V – 3.3V input, calibrated acc. calibration document
IO1…IO7 ADC channel accuracy - 5V LV channels with 1/3.3 divider		-45		45	mV	0V – 5V input, calibrated acc. calibration document
IO0, COMM ADC channel accuracy - 5V LV channels with 1/3.3 divider		-60		60	mV	0V – 5V input, calibrated acc. calibration document
ADC channel accuracy - HV channels with 1/18 divider		-0.40		0.40	V	<20V input, calibrated acc. calibration document
ADC channel accuracy - VSMF channel with 1/18 divider		-0.20		0.20	V	<20V input, calibrated acc. calibration document, 0C-85C Temp. range
ADC channel accuracy - temperature channel		-10		10	ºC	Calibrated acc. calibration document

Table 18 – Electrical specifications: ADC

12.4.8. IO

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Input threshold level L → H				2.4	V	
Input threshold level H → L		1			V	
Input hysteresis		0.1			V	
Output voltage L, IO0,1,…7, COMM				0.4	V	ILOAD = 3mA
Output voltage H, IO0,1…7, COMM		VDDA - 0.4V			V	ILOAD = 3mA
Output voltage H, IO0,1…7, COMM		VDDA - 0.4V			V	ILOAD = 3mA
Input voltage range for HV IO0 ADC measurement		0		28	V	IO0 high voltage input Measurement of IO0/18
Input voltage range for phase U,V,W,T ADC measurement		0		28	V	U,V,W,T driver phase sensing Measurement of U,V,W,T /18
Input voltage range for low-voltage ADC measurement		0		VDDA	V	IO0...7 Measurement of IOx/2.2
I2C SDA hold time (vs SCL)		0	5	10	ns	IO0 pin, SDAFILT_IO=00, setting for Fast-mode Plus
I2C SDA hold time (vs SCL)		100	150	200	ns	IO0 pin, SDAFILT_IO=01
I2C SDA hold time (vs SCL)		210	300	390	ns	IO0 pin, SDAFILT_IO=10
I2C SDA hold time (vs SCL)		320	450	580	ns	IO0 pin, SDAFILT_IO=11, setting for Standard-mode and Fast-mode

Table 19 – Electrical specifications: IO

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