MLX83202/83203/83100

Automotive NFET pre-drivers

Features and Benefits

- Converts 6 (or 3) PWM inputs from a micro-controller to drive 6 external N-FETs
- High side NFET driver with bootstraps
- Optional Charge pump allows operation at low supply voltage.
  - Charge pump capable to drive six 300nC FETs at 20kHz
- Wide supply voltage operating range: [4.5, 32]V
- Automotive qualified
  - 45V load dump, 28V jump start
- Sleep mode with low quiescent current (<30uA)
- Compatible with 3V and 5V micro-controllers
- Low Side current sense amplifier with low offset and low offset drift
  - Fast settling time (GBW > 10MHz)
  - Programmable gain: 8 to 48
  - Configurable Input range. Ex. for Gain=8 from [-0.25, 0.25]V to [0, 0.5]V
- Extensive diagnostics
  - Supply Under & Over Voltage
  - Charge pump Under & Over Voltage
  - Overtemperature protection
  - External NFET VDS monitoring for short circuit protection (programmable)
  - Configurable communication interface for diagnostics feedback
- EEPROM
  - Extensive configurability
  - ECC error correction per word
- Very small package: 32 pins QFN 5*5mm (footprint: 25mm^2)
- 2000Hrs HTOL 150C

Ordering Information

Part No.	Temperature Code	Package Code	RDSon
MLX83203	K (-40°C to 125°C)	LQ (QFN32, 5x5mm)	< 8 Ohm
On high volume request:			
MLX83203	*K (-40°C to 125°C)*	*PF (TQFP48, 7x7mm)*	*< 8 Ohm*
MLX83202	*K (-40°C to 125°C)*	*LQ (QFN32, 5x5mm)*	*<25 Ohm*
MLX83202	*K (-40°C to 125°C)*	*PF (TQFP48, 7x7mm)*	*<25 Ohm*
<2 phase option>			
MLX83100	*K (-40°C to 125°C)*	*GO (TSSOP28-Exp.Pad)*	*<25 Ohm*

Application Examples

- Electric steering (EPS/EHPS), Electric Braking
- Positioning actuators: Transmission, General purpose engine actuators, …
- High-power fan /pump drivers
- Wipers, seat belt retractors, …

1 General Description

The MLX8320x is family of 3 phase predrivers, optimised for fail safe control of high current applications requiring torque or sine wave motor control. It converts 6 (or 3) logic inputs from a micro-controller to drive 6 external N-FETs.
The MLX8320x leverages EEPROM to offer a wide range of configuration options.
At the same time the EEPROM configurability avoids the need for a high pin count package, which is typically required for predrivers that are configured using external resistors.

Several fail safe operating features are foreseen, including extensive diagnostics features. Diagnostics feedback is communicated to the ECU via a bidirectional PWM communication interface.
Finally the MLX8320x features a low side shunt amplifier with large Gain Bandwidth (GBW), ideal for Torque control applications requiring very fast settling time and minimum noise.

2 Glossary of Terms

OVT	Over Temperature
OV	Over Voltage
UV	Under voltage
POR	Power ON Reset
CP	Charge pump
VDD	Logic supply (3.3V or 5V)
Vds	Drain-source voltage

3 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Battery Voltage (overvoltage, load dump)		45	V
Battery Voltage (battery reversal)		-0.5V	V
IO Supply Voltage (overvoltage)		7	V
IO Supply Voltage (operating)		5.5	V
Ambient Operating Temperature Range		-40 to 125	°C
Junction operating Temperature Range (*)		-40 to 150	°C
Junction Temp. transient peak (*)		175	°C
Storage Temperature Range		-50 to 150	°C
ESD Sensitivity (AEC Q100 002)		+/-2	kV

Table 1: Absolute maximum ratings

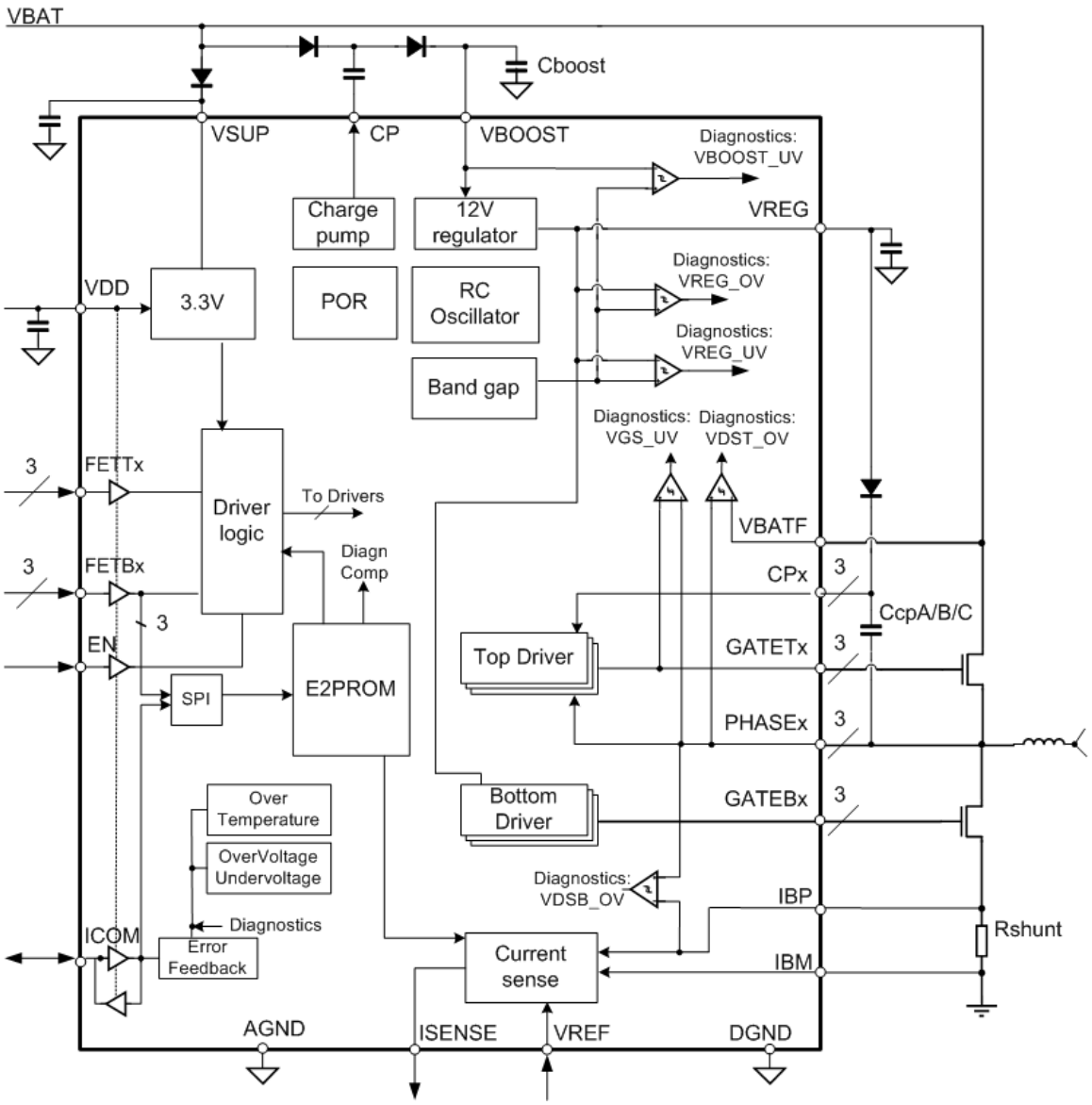
(*) Possible after review of the application mission profile.

4 Pin Definitions and Descriptions

MLX8320x QFN32	Name	Type	Function
1	IBM	Analog	Current sensor input (negative input)
2	IBP	Analog	Current sensor input (positive input)
3	ISENSE	Analog	Current sensor output; Diagnostic output in case of Fault
4	FETB1	Digital	PWM input for Bottom n-FET1
5	FETB2	Digital	PWM input for Bottom n-FET2
6	FETB3	Digital	PWM input for Bottom n-FET3
7	ICOM	IO	Diagnostic feedback IO
8	EN	IO	Enable input
9	PHASE2	Phase	Motor phase 2
10	GATET2	Output	PWM output to Top n-FET2 Gate
11	CP2	Supply	Charge pump supply for Top n-FET2
12	PHASE1	Phase	Motor phase 1
13	GATET1	Output	PWM output to Top n-FET1 Gate
14	CP1	Supply	Charge pump supply for Top n-FET1
15	PHASE3	Phase	Motor phase 3
16	GATET3	Output	PWM output to Top n-FET3 Gate
17	CP3	Supply	Charge pump supply for Top n-FET3
18	VBOOST	Analog	Charge pump generated supply, unregulated
19	VREG	Analog	regulated output from charge pump to drive n-FET gates
20	GATEB2	Output	PWM output to Bottom n-FET2 Gate
21	GATEB3	Output	PWM output to Bottom n-FET3 Gate
22	GATEB1	Output	PWM output to Bottom n-FET1 Gate
23	DGND	Ground	Driver ground
24	CP	Analog	Charge pump driver output to boost low battery
25	VSUP	Supply	Power supply input
26	VBATF	Input	Supply for 3 Top n-FETs to monitor Vds
27	AGND	Ground	Analog ground
28	FETT2	Digital	PWM input for Top n-FET2
29	FETT1	Digital	PWM input for Top n-FET1
30	FETT3	Digital	PWM input for Top n-FET3
31	VDD	Supply	The input voltage on VDD is used to drive the digital IO's, and is used to supply the shunt amplifier. Sleep mode control: VDD = 0V puts the predriver in sleep mode
32	VREF	Analog	Reference voltage input for current sense

Table 2: Pin definitions and descriptions

5 Block diagram and principle application circuit



Block Diagram

6 Configurability

6.1 VREF: shunt amplifier common mode input voltage

ISENSE voltage varies between GND and VDD.
The amplifier input range can be configured from fully symmetric to maximum range by adjusting VREF as a ratio of VDD.

6.2 EEPROM

One of the unique features of the MLX83203 is its configurability in EEPROM, which allows the use of a small 32 pins package.

Following data can be programmed in the chip:

- *IC identification number for traceability (MLX only)*
- *IC trimming (MLX only)*
- **Shunt amplifier gain**
- **Dead time**
- **VDS monitoring**
- **Blanking time for VDS monitoring**
- **Hardware protection: on/off**
- **Diagnostic modes**
- **Charge pump: NFET reverse polarity or not.**

The configuration data (excluding identification and trimming data) can be programmed during customer production testing using a PTC-04, or by the microcontroller via an SPI interface which can only be activated while the predriver is not active (Enable = low).

6.3 Hardware protection

Hardware protection refers to the possibility to automatically switch off the power stage (gate voltage of all FETs pulled low) when an error condition occurs:

6.4 Diagnostics modes: ICOM configuration options

ICOM is a bidirectional PWM channel.

- All 10 errors have their predefined (5bit) duty cycle value.
- The microcontroller has to acknowledge the receipt of the error by pulling the ICOM line low.

6.5 SPI:

An SPI interface is integrated in order to program the EEPROM via the microcontroller.

- SPI mode can only be entered when the Motor control is OFF (Enable is low).
- The four SPI pins are shared with the FETBx and ICOM pins.

6.6 NFET gate voltage regulation

The low side NFET gate voltage is defined by the linear 12V regulator VREG.
The high side NFET gate voltage is generated using bootstrap capacitors that are also supplied from VREG.

VREG is the output of a low drop linear regulator with VBOOST as voltage input.
Additionally a charge pump allows boosting VBOOST during low battery conditions.

The charge pump can be configured in EEPROM to regulate VBOOST to

- GND + 12V
- VSUP+12V, to apply a high side NFET for reverse polarity protection.

7 BLDC Application examples

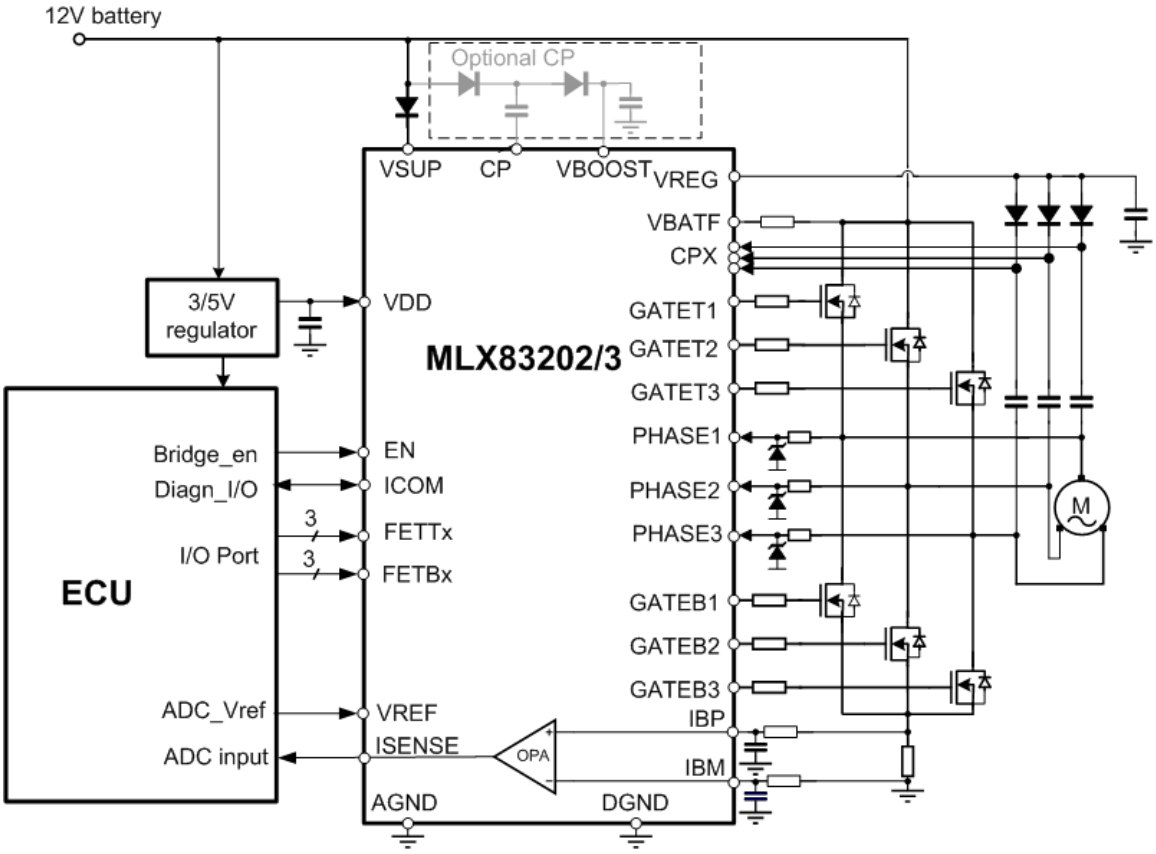
These are example applications. Additional components may be required for protection and decoupling purposes.

7.1 High end example like power steering

1. **Charge pump regulated to Ground**
   The charge pump is configured to regulate VBOOST to ground. This minimizes on–chip dissipation. For stable regulation Cboost is connected to ground.

2. **Six PWM inputs**
   The 6 FET's are individually controlled by the microcontroller with 6 PWM signals. The Microcontroller defines the dead time.

3. **ISENSE voltage**
   Applying VDD/2 on VREF sets the input range on the shunt amplifier fully symmetric.



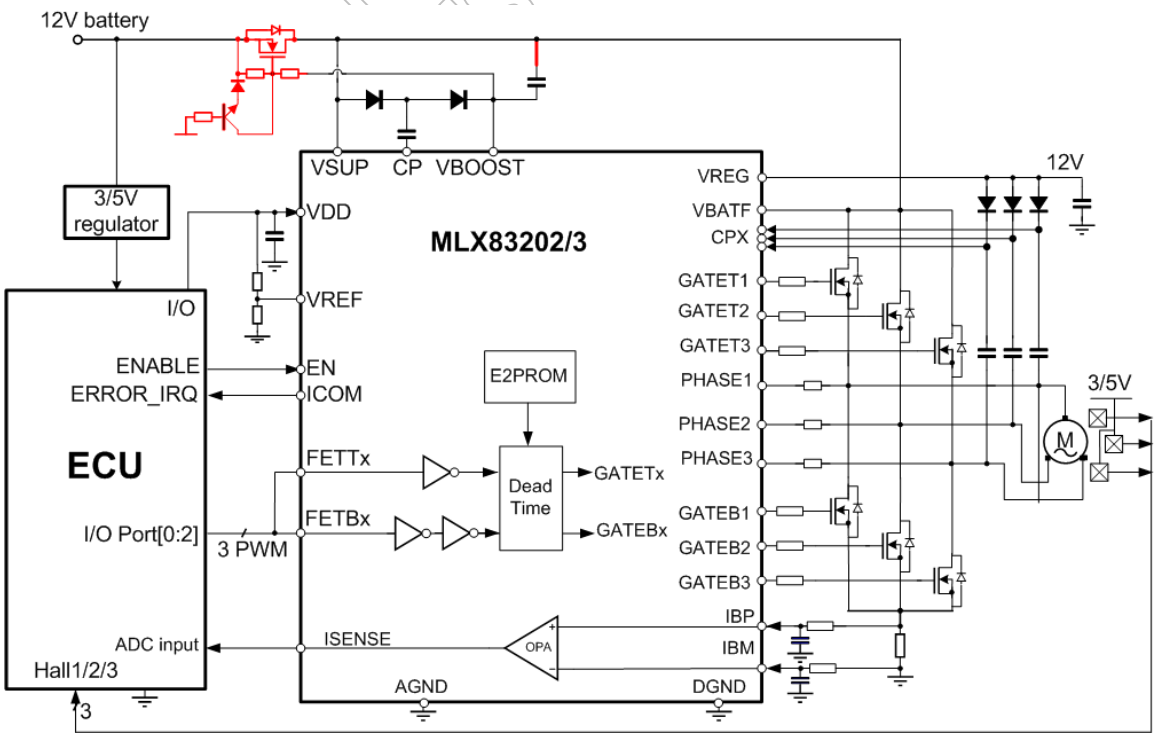
7.2 Low End Example

1. **Charge pump regulated to VSUP allows High Side NFET Reverse Polarity Protection**
   The MLX83203 can be configured to regulate VBoost ~ VSUP + VREG. To have a stable regulation Cboost has to be connected to VSUP. In this configuration VBOOST can be used to realize reverse polarity protection with a high side NFET. This NFET should be switched off fast in case of negative spikes on VBAT. For this purpose an NPN is applied on the gate of this NFET.
   VREG is regulated in a linear way from VBOOST.

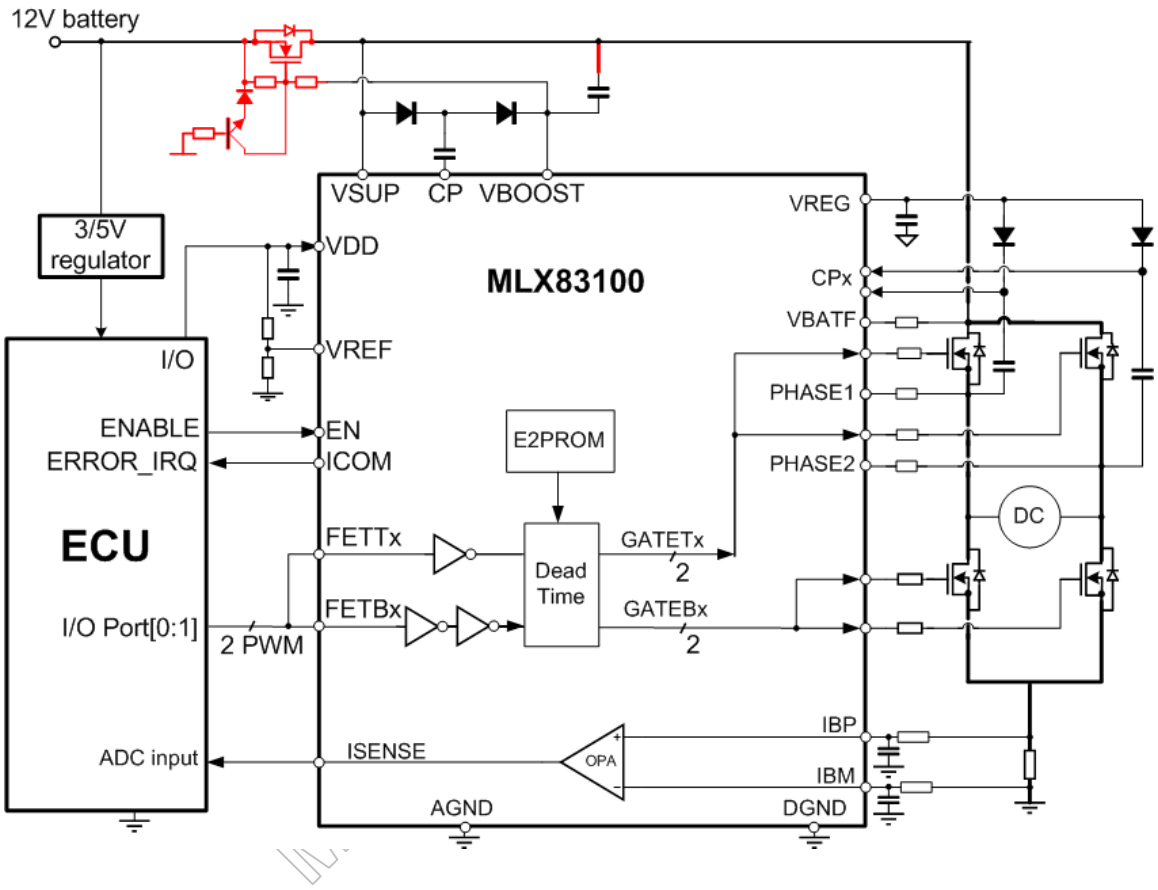
2. **Inhibit control by the MCU:**
   Connecting the VDD supply input to a (>20mA) digital output of the microcontroller allows to put the MLX83203 in sleep mode by pulling the digital output low.

3. **Three PWM inputs in stead of six**
   The schematic shows an application where a low-cost microcontroller controls a sensorless BLDC motor. The 3 halfbridges are controlled with only 3 PWM signals from the microcontroller. Dead times are automatically generated by the MLX83203, as programmed in the EEPROM.

4. **ISENSE voltage**
   Applying the corresponding resistor divider on the VREF input allows tuning the amplifier input range.



7.3 DC example



8 Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

Reflow Soldering SMD's (Surface Mount Devices)

- IPC/JEDEC J-STD-020
  Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
  (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113
  Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
  (reflow profiles according to table 2)

Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EN60749-20
  Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15
  Resistance to soldering temperature for through-hole mounted devices

Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

- EIA/JEDEC JESD22-B102 and EN60749-21
  Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: http://www.melexis.com/quality.asp

9 ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

10 Package Information

10.1 *Package data QFN32 (5x5, 32 leads)*

	A	A1	A3	b	D/E	D2/E2	e	K	L	N
min	0.80	0.00	0.20 REF	0.18	5.00 B.S.C	3.50	0.50 B.S.C	0.2	0.3	32
max	1.00	0.05		0.30		3.70		-	0.5	

Table 3: Mechanical Dimensions QFN32 5x5, all dimensions in mm

[1] General tolerance of D and E is +/-0.1mm
[2] Bottom pin 1 identification may vary depending on supplier

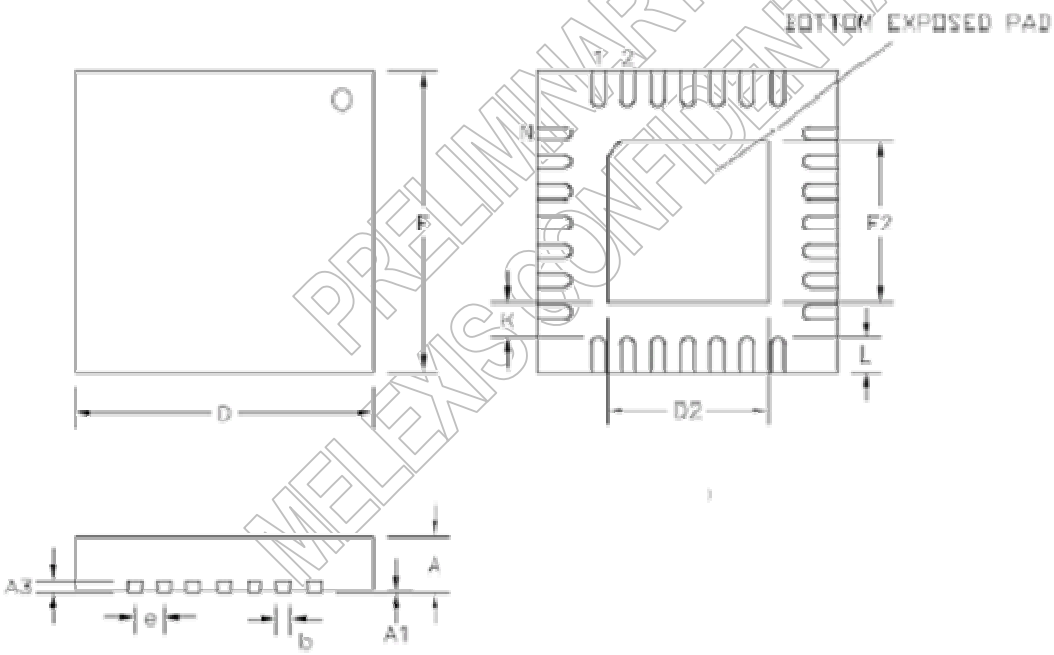


Figure 1: Package QFN32

10.2 *Package data TQFP48_EP 7x7 (48 leads, exposed pad)*

	A	A1	A2	D/E	D1/E1	D2/E2	e	L	N	b	c	α
Min	-	0.05	0.95	9.00	7.00	4.00	0.50	0.45	48	0.17	0.09	0°
Max	1.20	0.15	1.05	B.S.C	B.S.C	B.S.C	B.S.C	0.75		0.27	0.20	7°

Table 4: Mechanical Dimensions TQFP48_EP 7x7, all dimensions in mm

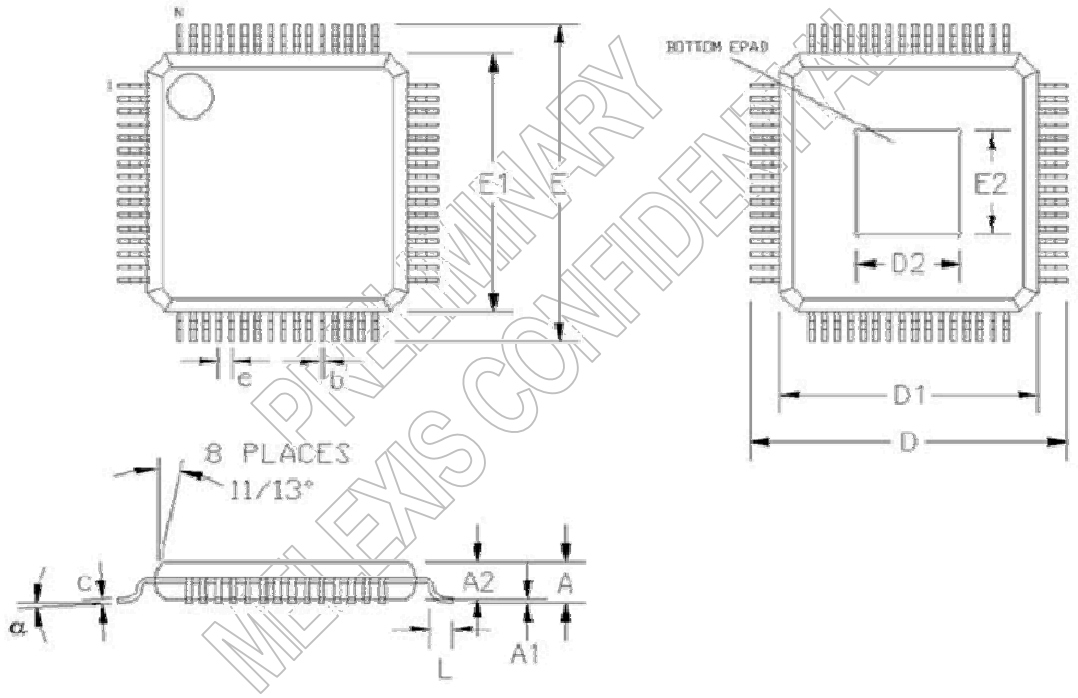


Figure 2: Package TQFP48_EP

10.3 Package data TSSOP28_EP (28 pins, exposed pad)

	A	A1	A2	D	E	H	e	L	b	c	α	P	P1
min		0.05	0.85	9.60	4.30	6.4 B.S.C	0.65 B.S.C	0.5	0.19	0.09	0°	3.00 B.S.C	5.50 B.S.C
Max	1.10	0.15	0.95	9.80	4.50			0.75	0.30	0.20	8°		

Table 5: Mechanical Dimensions TSSOP28_EP, all dimensions in mm

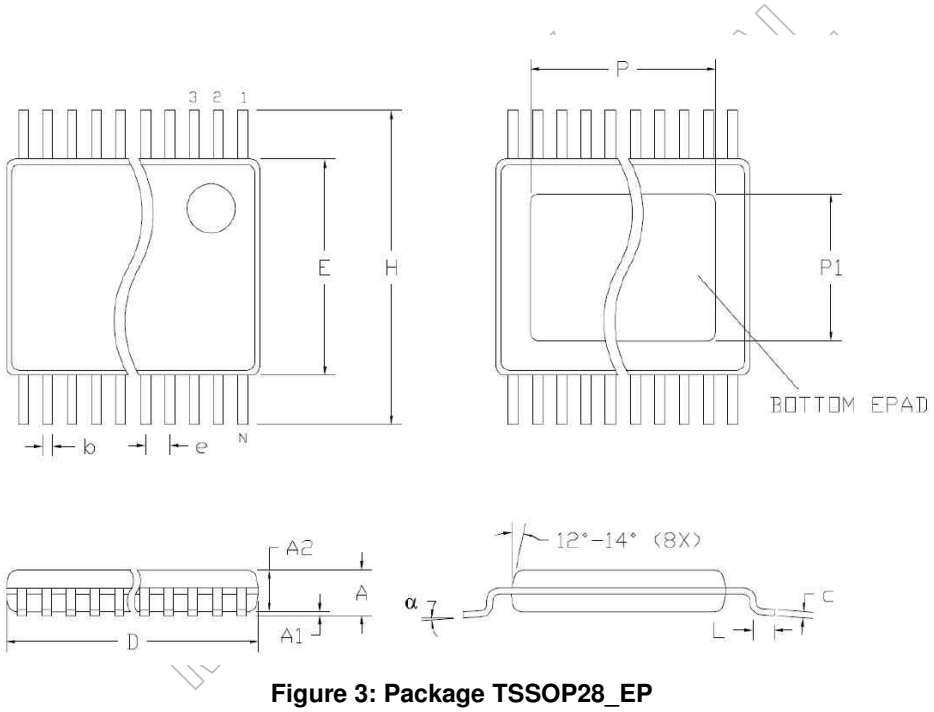


Figure 3: Package TSSOP28_EP

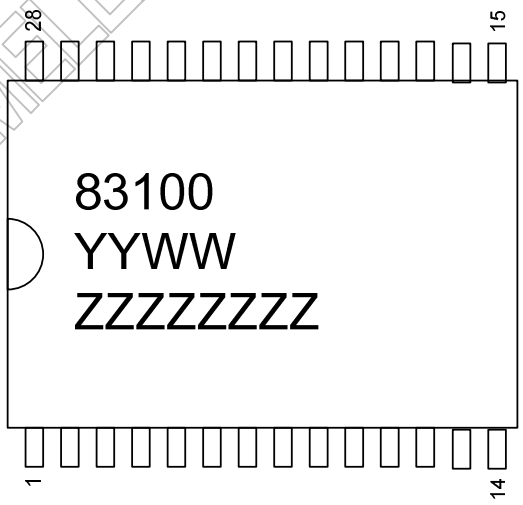
10.4 Package Marking

Product name:	MLX8320X	X = 2 or 3
Date Code:	YYWW	year and week
Lot number	ZZZZZZZZ	format free

Top view of the package

Product name:	MLX83100	
Date Code:	YYWW	year and week
Lot number	ZZZZZZZZ	format free

Top view of the package



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