MD1821

High-Speed 4-Channel MOSFET Driver with Inverting Outputs

Features

- Inverting MOSFET Driver
- 6 ns Rise and Fall Time
- 2A Peak Output Source and Sink Currents
- 1.8V to 5V Input CMOS Compatible
- 5V to 10V Total Supply Voltage
- Smart Logic Threshold
- Low-jitter Design
- Four Matched Channels
- Drives Two P-channel and Two N-channel MOSFETs
- Outputs can Swing below Ground
- Low-inductance Quad Flat No-lead Package
- High-performance, Thermally Enhanced Package

Applications

- Medical Ultrasound Imaging
- Piezoelectric Transducer Drivers
- Non-destructive Testing (NDT)
- PIN Diode Driver
- CCD Clock Driver/buffer
- High-speed Level Translator

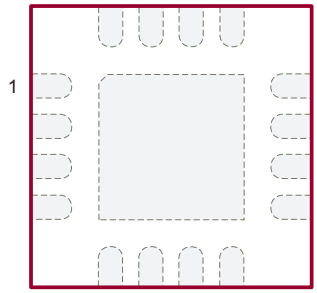
General Description

The MD1821 is a high-speed, 4-channel MOSFET driver designed to drive high-voltage P-channel and N-channel MOSFETs for medical ultrasound applications and other applications requiring a high output current for a capacitive load. The high-speed input stage of the MD1821 can operate from a 1.8V to 5V logic interface with an optimum operating input signal range of 1.8V to 3.3V. An adaptive threshold circuit is used to set the level translator switch threshold to the average of the input logic `0` and logic `1` levels. The input logic levels may be ground referenced even though the driver is putting out bipolar signals. The level translator uses a proprietary circuit, which provides DC coupling together with high-speed operation.

The output stage of the MD1821 has separate power connections, enabling the output signal L and H levels to be chosen independently from the supply voltages used for the majority of the circuit. As an example, the input logic levels may be 0V and 1.8V, the control logic may be powered by +5 and –5V and the output L and H levels may be varied anywhere over the range of –5 to +5V. The output stage is capable of peak currents of up to ±2A, depending on the supply voltages used and load capacitance present. The PE pin serves a dual purpose. First, its logic H level is used to compute the threshold voltage level for the channel input level translators. Second, when PE is low, the outputs are disabled, with the A and C outputs high and the B and D outputs low. This assists in properly precharging the AC coupling capacitors that may be used in series in the gate drive circuit of an external PMOS and NMOS transistor pair.

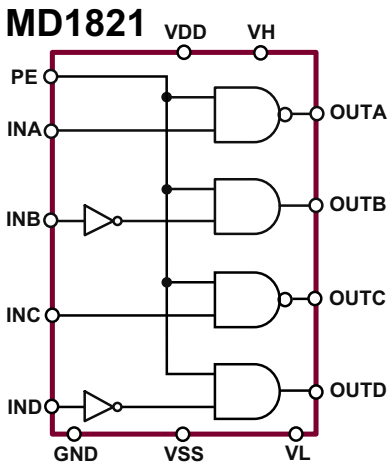
Package Type

16-lead QFN
(Top view)

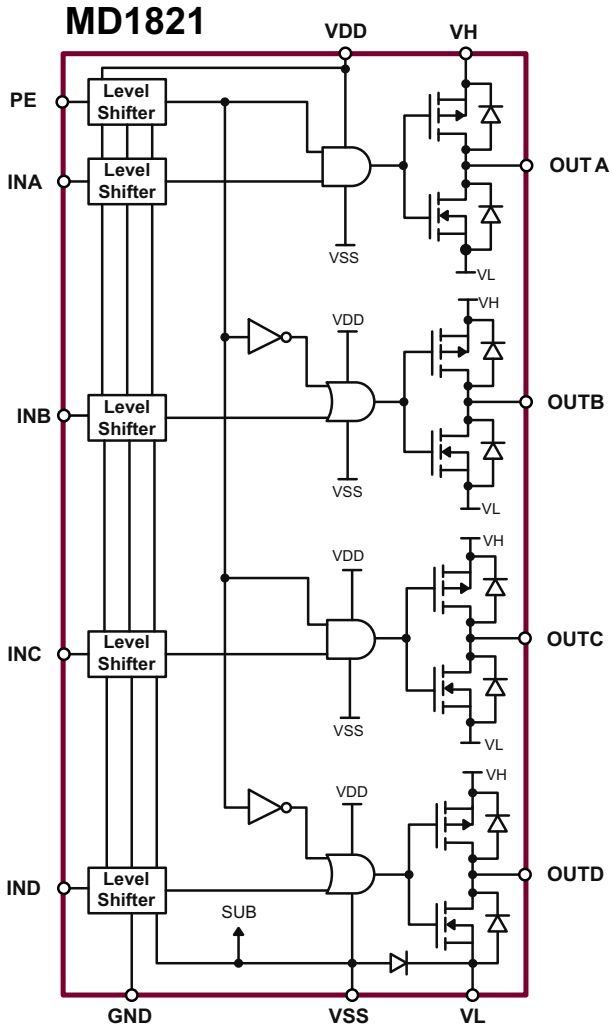


See Table 2-1 for pin information.

Functional Block Diagrams

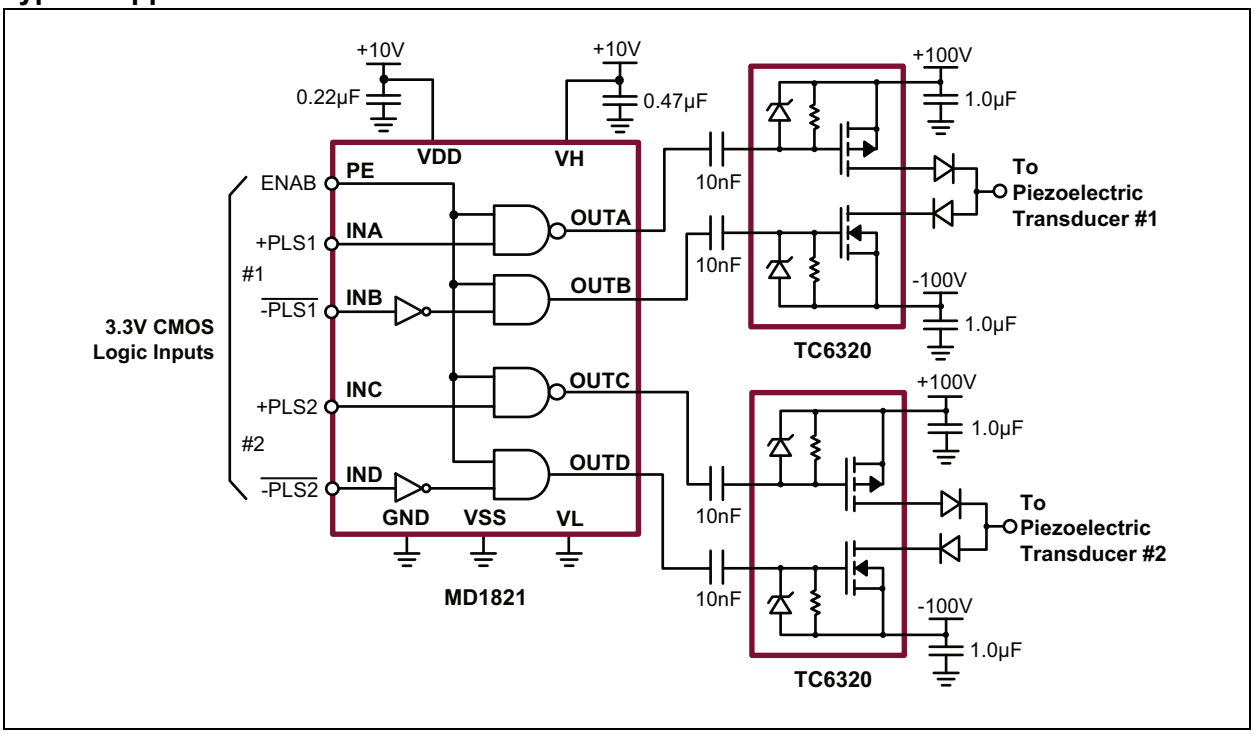


Simplified Block Diagram



Detailed Block Diagram

Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Logic Supply Voltage, V_{DD}–V_{SS} ..... –0.5V to +12.5V
Output High Supply Voltage, V_H ..... V_L–0.5V to V_{DD} +0.5V
Output Low Supply Voltage, V_L ..... V_{SS}–0.5V to V_H +0.5V
Low-side Supply Voltage, V_{SS} ..... –6V to +0.5V
Logic Input Levels ..... V_{SS}–0.5V to GND +5.5V
Maximum Junction Temperature, T_J ..... +125°C
Operating Ambient Temperature, T_A ..... –20°C to +85°C
Storage Temperature, T_S ..... –65°C to +150°C
Package Power Dissipation:
16-lead QFN 2.2W
ESD Rating (**Note 1**) ..... ESD Sensitive

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Note 1: Device is ESD sensitive. Handling precautions are recommended.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: V_H = V_{DD} = 10V, V_L = V_{SS} = GND = 0V, V_{PE} = 3.3V, T_A = 25°C

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Supply Voltage	V_{DD}–V_{SS}	4.75	—	11.5	V	4V ≤ V_{DD} ≤ 11.5V
Low-side Supply Voltage	V_{SS}	–5.5	—	0	V	
Output High Supply Voltage	V_H	V_{SS}+2	—	V_{DD}	V	
Output Low Supply Voltage	V_L	V_{SS}	—	V_{DD}–4	V	
V_{DD} Quiescent Current	I_{DDQ}	—	60		µA	No input transitions, PE = 0
V_H Quiescent Current	I_{HQ}	—	2	—	µA	
V_{DD} Quiescent Current	I_{DDQ}	—	1.3	—	mA	No input transitions, PE = 1
V_H Quiescent Current	I_{HQ}	—	2	—	µA	
V_{DD} Average Current	I_{DD}	—	3.5	—	mA	One channel on at 5 MHz, no load
V_H Average Current	I_H	—	10	—	mA	
Input Logic Voltage High	V_{IH}	V_{PE}–0.3	—	V_{PE}	V	For logic inputs INA, INB, INC and IND
Input Logic Voltage Low	V_{IL}	0	—	0.3	V	
Input Logic Current High	I_{IH}	—	—	1	µA	
Input Logic Current Low	I_{IL}	—	—	1	µA	
PE Input logic Voltage High	V_{IH}	1.7	3.3	5.25	V	For logic input PE
PE Input Logic Voltage Low	V_{IL}	0	—	0.3	V	
PE Input Resistance	R_{IN_PE}	100	—	—	kΩ	
Logic Input Capacitance	C_{IN}	—	5	10	pF	
Output Sink Resistance	R_{SINK}	—	1.5	—	Ω	I_{SINK} = 50 mA
Output Source Resistance	R_{SOURCE}	—	2	—	Ω	I_{SOURCE} = 50 mA
Peak Output Sink Current	I_{SINK}	—	2	—	A	
Peak Output Source Current	I_{SOURCE}	—	2	—	A	

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: $V_H = V_{DD}$ = 10V, $V_L = V_{SS}$ = GND = 0V, V_{PE} = 3.3V, T_A = 25°C						
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Unit**	**Conditions**
Input or PE Rise and Fall Time	t_{irf}	—	—	10	ns	Logic input edge speed requirement
Propagation Delay when Output is from Low to High	t_{PLH}	—	6.5	—	ns	C_{LOAD} = 1000 pF (See **Timing Diagram**.), input signal rise/fall time 2 ns
Propagation Delay when Output is from High to Low	t_{PHL}	—	6.5	—	ns	
Output Rise Time	t_r	—	7	—	ns	
Output Fall Time	t_f	—	7	—	ns	
Rise and Fall Time Matching	$\lvert t_r - t_f \rvert$	—	1	—	ns	For each channel
Propagation Low to High and High to Low Matching	$\lvert t_{PLH} - t_{PHL} \rvert$	—	1	—	ns	
Propagation Delay Matching	Δt_{dm}	—	±2	—	ns	Device-to-device delay match
PE On Time	t_{PE-ON}	—	—	5	µs	V_{PE} = 1.7V~5.25V, V_{DD} = 7.5V~11.5V, –20°C~85°C
PE Off-time	t_{PE-OFF}	—	—	4	µs	

TEMPERATURE SPECIFICATIONS

Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Unit**	**Conditions**
TEMPERATURE RANGE						
Maximum Junction Temperature	T_J	—	—	+125	°C	
Operating Ambient Temperature	T_A	–20	—	+85	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
16-lead QFN	θ_{JA}	—	55	—	°C/W	**Note 1**

Note 1: 1 oz four-layer 3” x 4” PCB

Timing Diagram

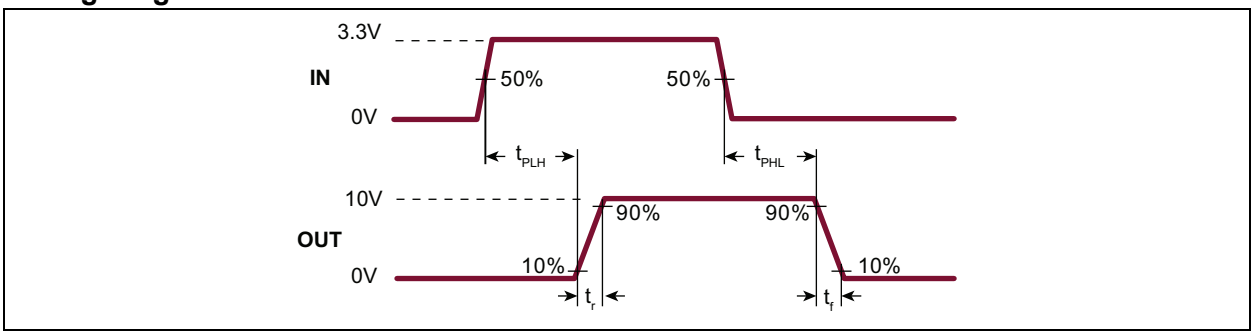


TABLE 1-1: TRUTH FUNCTION TABLE

Logic Inputs			Outputs	
PE	**INA**	**INB**	**OUTA**	**OUTB**
H	L	L	V_H	V_H
H	L	H	V_H	V_L
H	H	L	V_L	V_H
H	H	H	V_L	V_L
L	X	X	V_H	V_L
PE	**INC**	**IND**	**OUTC**	**OUTD**
H	L	L	V_H	V_H
H	L	H	V_H	V_L
H	H	L	V_L	V_H
H	H	H	V_L	V_L
L	X	X	V_H	V_L

2.0 PIN DESCRIPTION

The details on the pins of MD1821 are listed on Table 2-1. See **Package Type** for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	INB	Logic input
2	VDD	High-side supply voltage
3	VSS	Low-side supply voltage. VSS is also connected to the IC substrate. It is required to connect to the most negative potential of voltage supplies.
4	INC	Logic input
5	IND	
6	GND	Logic input ground reference
7	VL	Supply voltage for N-channel output stage
8	OUTC	Output drivers
9	OUTD	
10, 11	VH	Supply voltage for P-channel output stage
12	OUTA	Output drivers
13	OUTB	
14	VL	Supply voltage for N-channel output stage
15	PE	Power enable logic input. When PE is high, the input logic threshold is set. When PE is low, all outputs are at default state and the IC is in Standby mode. (See Table 1-1 and Figure 3-1.)
16	INA	Logic input
Substrate		The IC substrate is internally connected to the thermal pad. The thermal pad and VSS must be connected externally.

3.0 APPLICATION INFORMATION

For proper operation of the MD1821, low-inductance bypass capacitors should be used in the various supply pins. The GND pin should be connected to the logic ground. The INA, INB, INC, IND and PE pins should be connected to a logic source with a swing of GND to PE, where PE is 1.8V to 5V. Good trace practices should be followed corresponding to the desired operating speed. The internal circuitry of the MD1821 is capable of operating up to 100 MHz, with the primary speed limitation being the loading effects of the load capacitance. Because of this speed and the high transient currents due to capacitive loads, the bypass capacitors should be as close to the chip pins as possible. Unless the load specifically requires bipolar drive, the V_{SS} and V_L pins should have a low-inductance bypass capacitor to GND and supply power connections. If these voltages are not zero, they need bypass capacitors similar to the positive power supplies. The power connection V_{DD} should have a ceramic bypass capacitor to the ground plane with short leads and decoupling components to prevent resonance in the powerleads.

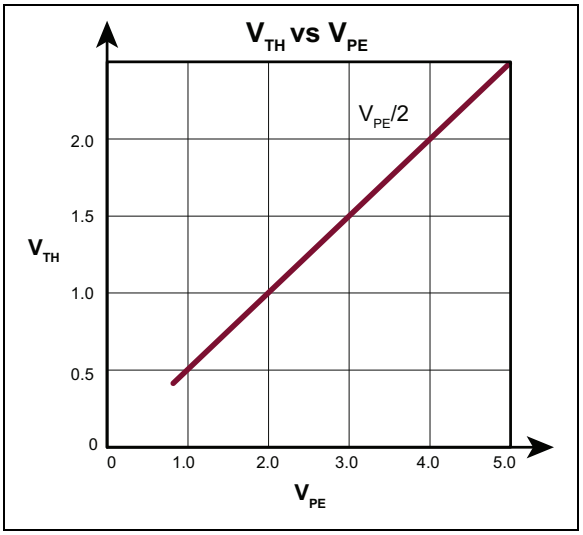


FIGURE 3-1: *V_{TH}/V_{PE} Curve.*

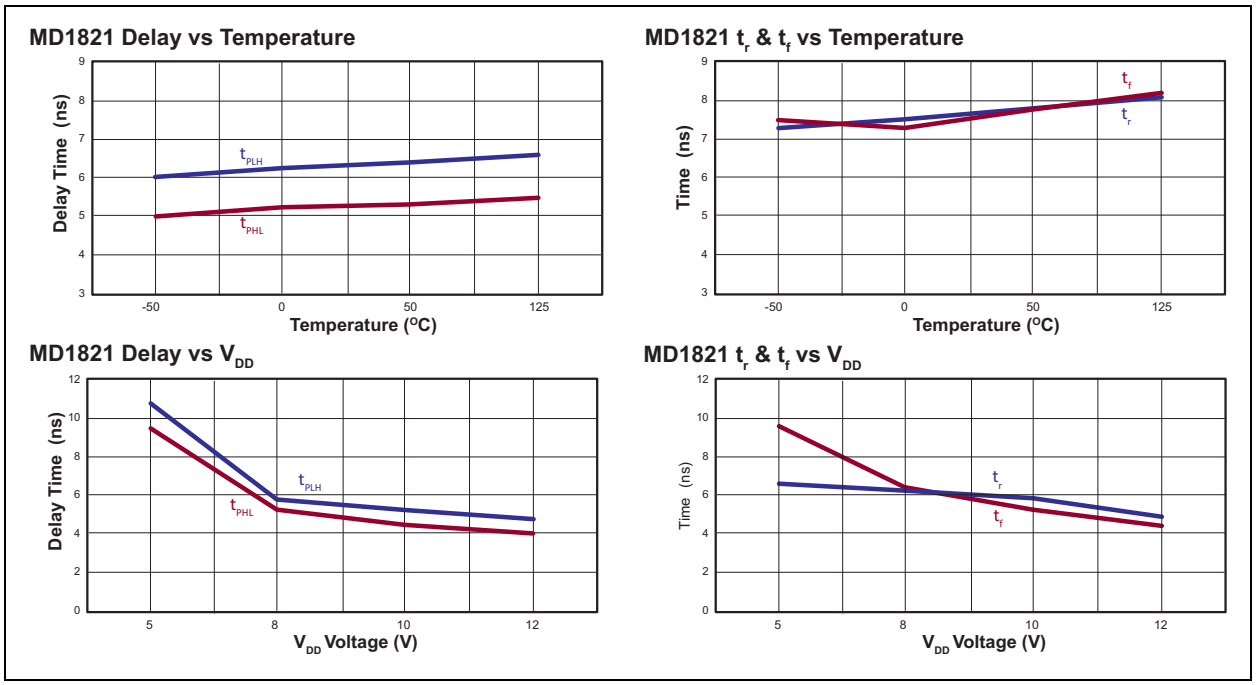


FIGURE 3-2: *Timing Characteristics vs. Temperature and V_{DD}.*

The voltages of V_H and V_L decide the output signal levels. These two pins can draw fast transient currents of up to 2A, so they should be provided with an appropriate bypass capacitor located next to the chip pins. A ceramic capacitor of up to 1 µF may be appropriate, with a series ferrite bead to prevent resonance in the power supply lead going to the capacitor. Pay particular attention to minimizing trace lengths, current loop area and using sufficient trace width to reduce inductance. Surface-mount components are highly recommended. Since the output impedance of this driver is very low, in some cases, it may be desirable to add a small series resistor in series with the output signal to obtain better waveform transitions at the load terminals. This will reduce the output voltage slew rate at the terminals of a capacitive load.

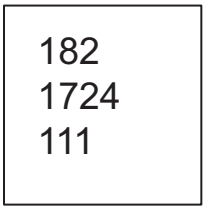
Make sure that parasitic couplings are minimized from the output to the input signal terminals. The parasitic feedback may cause oscillations or spurious waveform shapes on the edges of signal transitions. Since the input operates with signals down to 1.8V, even small coupled voltages may cause problems. The use of a solid ground plane and good power and signal layout practices will prevent this problem. Make sure that the circulating ground return current from a capacitive load will not react with common inductance to cause noise voltages in the input logic circuitry.

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

16-lead QFN

Example

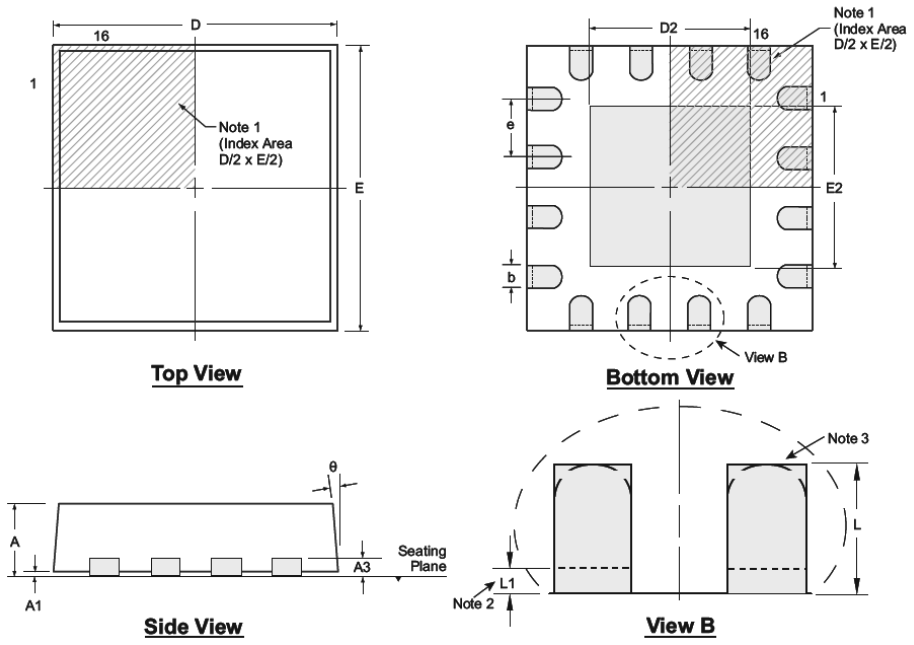


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

16-Lead QFN Package Outline (K6)

3.00x3.00mm body, 1.00mm height (max), 0.50mm pitch



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Notes:

1. *A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*
2. *Depending on the method of manufacturing, a maximum of 0.15mm pullback (L1) may be present.*
3. *The inner tip of the lead may be either rounded or square.*

Symbol		A	A1	A3	b	D	D2	E	E2	e	L	L1	θ
Dimension (mm)	MIN	0.80	0.00	0.20 REF	0.18	2.85*	1.50	2.85*	1.50	0.50 BSC	0.20†	0.00	0°
	NOM	0.90	0.02		0.25	3.00	1.65	3.00	1.65		0.30†	-	-
	MAX	1.00	0.05		0.30	3.15*	1.80	3.15*	1.80		0.45	0.15	14°

JEDEC Registration MO-220, Variation VEED-4, Issue K, June 2006.
** This dimension is not specified in the JEDEC drawing.*
† This dimension differs from the JEDEC drawing.
Drawings not to scale.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (May 2017)

- Converted Supertex Doc# DSFP-MD1821 to Microchip DS20005768A
- Changed the package marking format
- Changed the quantity of the K6 package from 3000/Reel to 3300/Reel
- Made minor text changes throughout the document

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	MD1821	=	High-Speed 4-Channel MOSFET Driver with Inverting Outputs
Package:	K6	=	16-lead QFN
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	3300/Reel for a K6 Package

Example:

a) MD1821K6-G: High-Speed 4-Channel MOSFET Driver with Inverting Outputs, 16-lead QFN, 3300/Reel

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