

3-Channel 3-Level High-Speed Ultrasound Driver IC

Features

- Advanced CMOS Technology
- $\pm 4.5\text{V}$ to 12.5V Power Supply Voltage
- 2A Output Source and Sink Current
- 6.5 ns Rise and Fall Time with 1 nF Load
- 10 ns Propagation Delay
- $\pm 2\text{ ns}$ Matched Delay Times
- 12 Matched Channels
- 1.8V to 3.3V CMOS Logic Interface
- Smart Logic Threshold
- Low-Inductance Package

Applications

- Medical Ultrasound Imaging
- Piezoelectric Transducer Drivers
- Metal Flaw Detection
- Non-destructive Testing (NDT)

General Description

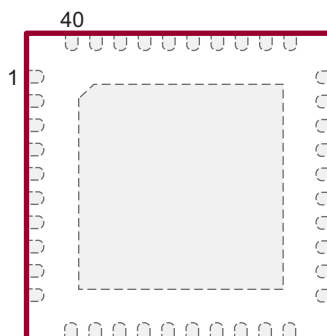
The MD1716, paired with Microchip's TC8020, forms a 3-channel 3-level high-voltage high-speed transmit pulser chip set. The chip set is designed for medical ultrasound imaging applications but can also be used for metal flaw detection, NDT, and piezoelectric transducer drivers.

The MD1716 is a 3-channel logic controller circuit with 12 low-impedance MOSFET gate drivers. There are three sets of control logic inputs—one for Channel A, one for Channel B, and one for Channel C. Each channel consists of two pairs of MOSFET gate drivers. These drivers are designed to match the drive requirements of Microchip's TC8020.

The TC8020 is the high-voltage output stage of the pulser with six pairs of MOSFETs. Each pair consists of a P-channel and an N-channel MOSFET. They are designed to have the same impedance and can provide typical peak currents of $\pm 3.5\text{A}$.

Package Type

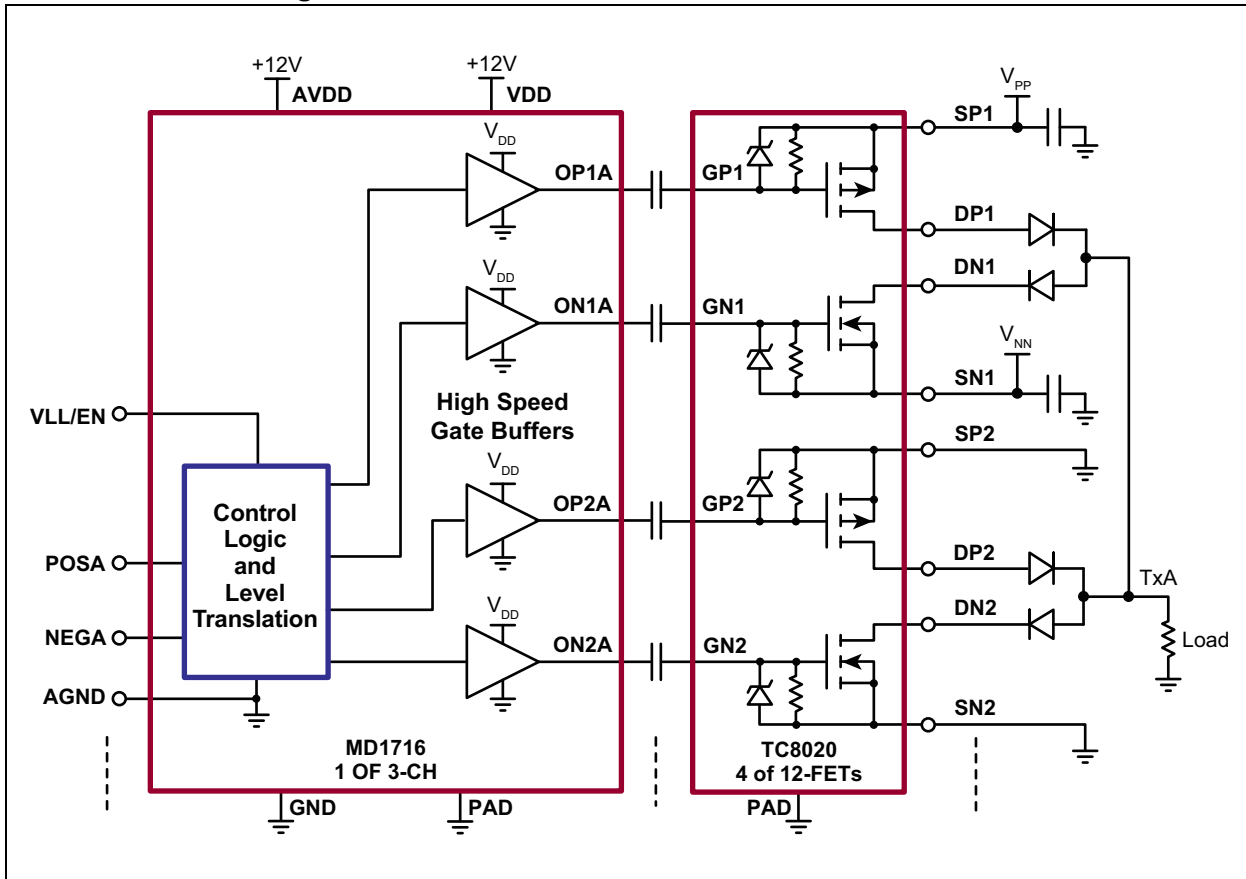
40-lead QFN
(Top view)



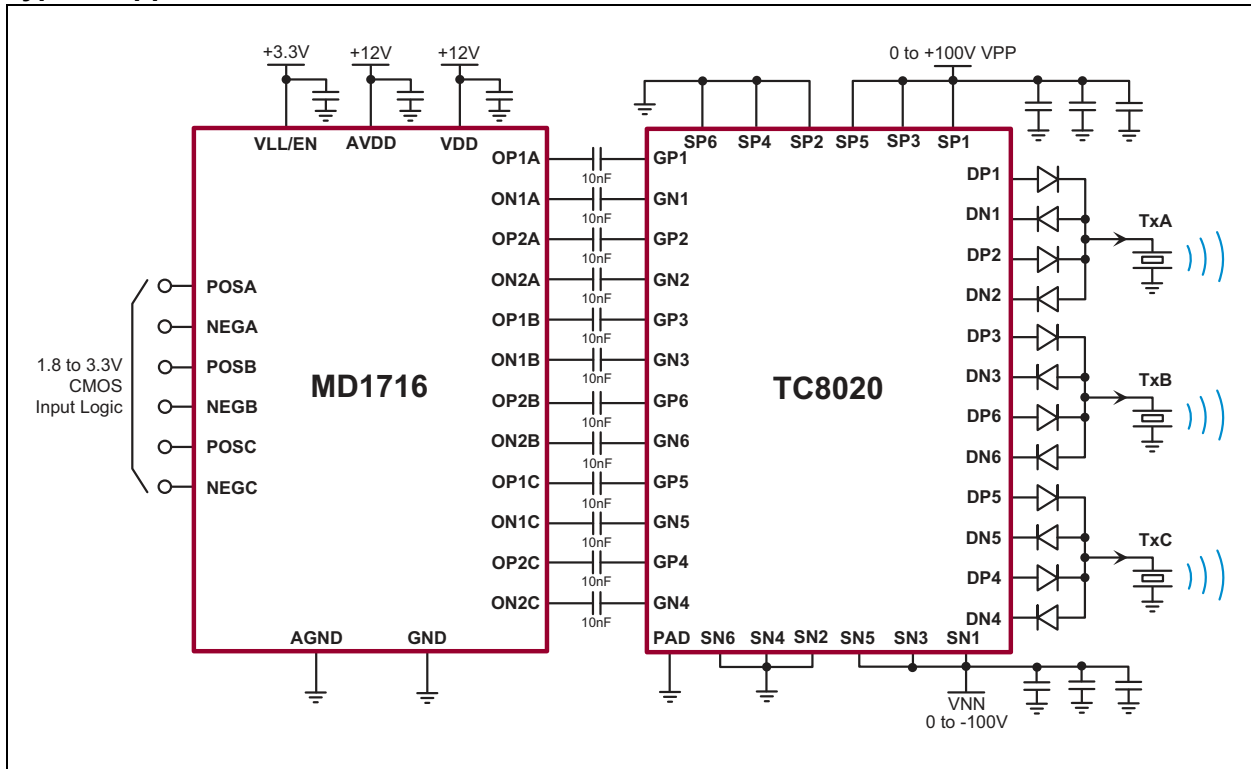
See [Table 2-1](#) for pin information.

MD1716

Functional Block Diagram



Typical Application Circuit



MD1716

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

GND and AGND, Ground	0V
Logic Input Pin, V_{LL}	-0.5V to +5.5V
Positive Gate Drive Supply, AV_{DD} , V_{DD1} , and V_{DD2}	-0.5V to +14.5V
Operating Junction Temperature, T_J	0°C to +125°C
Storage Temperature, T_S	-65°C to +150°C
Power Dissipation:	
40-lead QFN (Note 1)	1.3W

† **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: 1 oz. four-layer 3 inches x 4 inches PCB

OPERATING SUPPLY VOLTAGES AND CURRENTS

Electrical Specifications for Operating Supply Currents: Over operating conditions unless otherwise specified.

$V_{LL} = 3.3V$, $AV_{DD} = V_{DD} = +12V$, and $T_A = 25^\circ C$

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Supply	V_{LL}	1.8	3.3	3.6	V	
Positive Analog Supply	AV_{DD}	4.75	—	12.9	V	$AV_{DD} \geq V_{DD}$
Positive Gate Drive Supply	V_{DD}	4.75	—	12.9	V	
Logic Reference Current	I_{VLL}	—	10	—	μA	$V_{LL} = 3.3V$
AV_{DD} Power-Down Current	I_{AVDDQ}	—	400	—	μA	EN = 0, all inputs low
V_{DD} Power-Down Current	I_{VDDQ}	—	50	100	μA	
AV_{DD} Power-Up Current	I_{AVDDEN}	—	2	3	mA	EN = 1, all inputs low
V_{DD} Power-Up Current	I_{VDDEN}	—	0.7	1	mA	
AV_{DD} CW 5 MHz Current	I_{AVDDCW}	—	10	—	mA	All channels on at 5 MHz, no load, $V_{DD} = 5V$
V_{DD} CW 5 MHz Current	I_{VDDCW}	—	33	—	mA	

DC ELECTRICAL CHARACTERISTICS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions	
P-CHANNEL AND N-CHANNEL GATE DRIVER OUTPUTS							
Output Sink Resistance	P-Channel	R_{SINK}	—	—	6	Ω	$I_{SINK} = 100\text{ mA}$
	N-Channel		—	3	6	Ω	
Output Source Resistance	P-Channel	R_{SOURCE}	—	—	6	Ω	$I_{SOURCE} = 100\text{ mA}$
	N-Channel		—	4	6	Ω	
Peak Output Sink Current	P-Channel	I_{SINK}	1.7	2	—	A	
	N-Channel		1.7	2	—	A	
Peak Output Source Current	P-Channel	I_{SOURCE}	1.7	2	—	A	
	N-Channel		1.7	2	—	A	
LOGIC INPUTS							
Chip Disable Low Voltage	V_{ENL}	0	—	0.3	V	V_{LL}/EN is a dual function pin.	
Input Logic High Voltage	V_{IH}	$0.8 V_{LL}$	—	V_{LL}	V		

DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input Logic Low Voltage	V_{IL}	0	—	$0.2 V_{LL}$	V	
Input Logic High Current	I_{IH}	—	—	1	μA	
Input Logic Low Current	I_{IL}	-1	—	—	μA	

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over operating conditions unless otherwise specified. $V_{LL} = 3.3V$, $A V_{DD} = V_{DD} = +12V$, and $T_A = 25^\circ C$

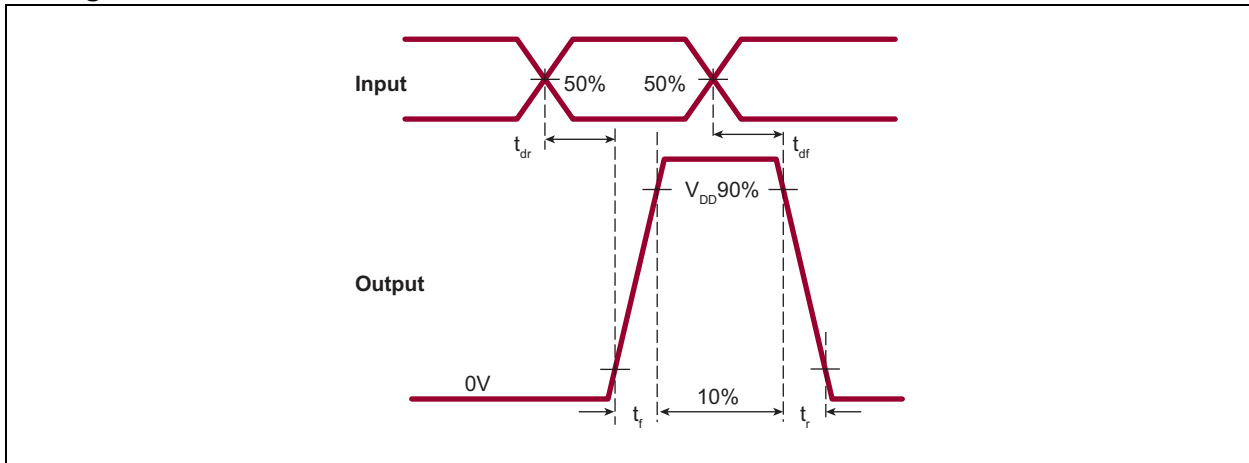
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input Rise and Fall Time	t_{irf}	—	—	10	ns	Logic input edge speed requirement
Output Rise Time	t_r	—	6.5	—	ns	1 nF load, input signal rise/fall time 2 ns (See Timing Waveforms.)
Output Fall Time	t_f	—	6.5	—	ns	
Output Rise Delay	t_{dr}	—	10	—	ns	1 nF load, input signal rise/fall time 2 ns (See Timing Waveforms.)
Output Fall Delay	t_{df}	—	10	—	ns	
Rise and Fall Time Matching	$ t_r - t_f $	—	1	—	—	For each channel
Propagation Delay Matching	$ t_{dr} - t_{df} $	—	1	—	—	
Delay Time Matching	t_{dm}	—	± 2	—	ns	Channel to channel and device to device
Output Jitter	Δt_j	—	20	—	ps	$V_{DD} = 10V$
IC Enable Time	t_{EN_ON}	—	—	50	μs	
IC Disable Time	t_{EN_OFF}	—	—	2	μs	

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Junction Temperature	T_J	0	—	+125	$^\circ C$	
Storage Temperature	T_S	-65	—	+150	$^\circ C$	
PACKAGE THERMAL RESISTANCE						
40-lead QFN	θ_{JA}	—	24	—	$^\circ C/W$	

MD1716

Timing Waveforms



2.0 PIN DESCRIPTION

The details on the pins of MD1716 are listed in [Table 2-1](#). See [Package Type](#) for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	POSA	POS input logic control for Channel A. See Table 3-1 for details.
2	NEGA	NEG input logic control for Channel A. See Table 3-1 for details.
3	POSB	POS input logic control for Channel B. See Table 3-2 for details.
4	VLL/EN	Logic high reference voltage and chip enable input
5	AVDD	Positive supply voltage of analog circuitry. AVDD should have the same or higher potential than the VDD.
6	AGND	Digital ground and connection of IC substrate
7	AGND	Digital ground and connection of IC substrate
8	NEGB	NEG input logic control for Channel B. See Table 3-2 for details.
9	POSC	POS input logic control for Channel C. See Table 3-3 for details.
10	NEGC	NEG input logic control for Channel C. See Table 3-3 for details.
11	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
12	OP2C	Damping P-channel gate driver for Channel C
13	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
14	GND	Power ground
15	OP1C	High-voltage output P-channel gate driver for Channel C
16	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
17	ON2C	Damping N-channel gate driver for Channel C
18	GND	Power ground
19	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
20	ON1C	High-voltage output N-channel gate driver for Channel C
21	GND	Power ground
22	ON2B	Damping N-channel gate driver for Channel B
23	GND	Power ground
24	OP2B	Damping P-channel gate driver for Channel B
25	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
26	GND	Power ground
27	OP1B	High-voltage output P-channel gate driver for Channel B
28	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
29	GND	Power ground
30	ON1B	High-voltage output N-channel gate driver for Channel B

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TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
31	ON2A	Damping N-channel gate driver for Channel A
32	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
33	GND	Power ground
34	ON1A	High-voltage output N-channel gate driver for Channel A
35	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
36	OP2A	Damping P-channel gate driver for Channel A
37	GND	Power ground
38	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
39	OP1A	High-voltage output P-channel gate driver for Channel A
40	VDD	Positive supply voltage of the gate drivers for the output stage in Channel A, Channel B, and Channel C
Center Pad	Thermal pad	IC substrate. It must connect to GND externally.

3.0 FUNCTIONAL DESCRIPTION

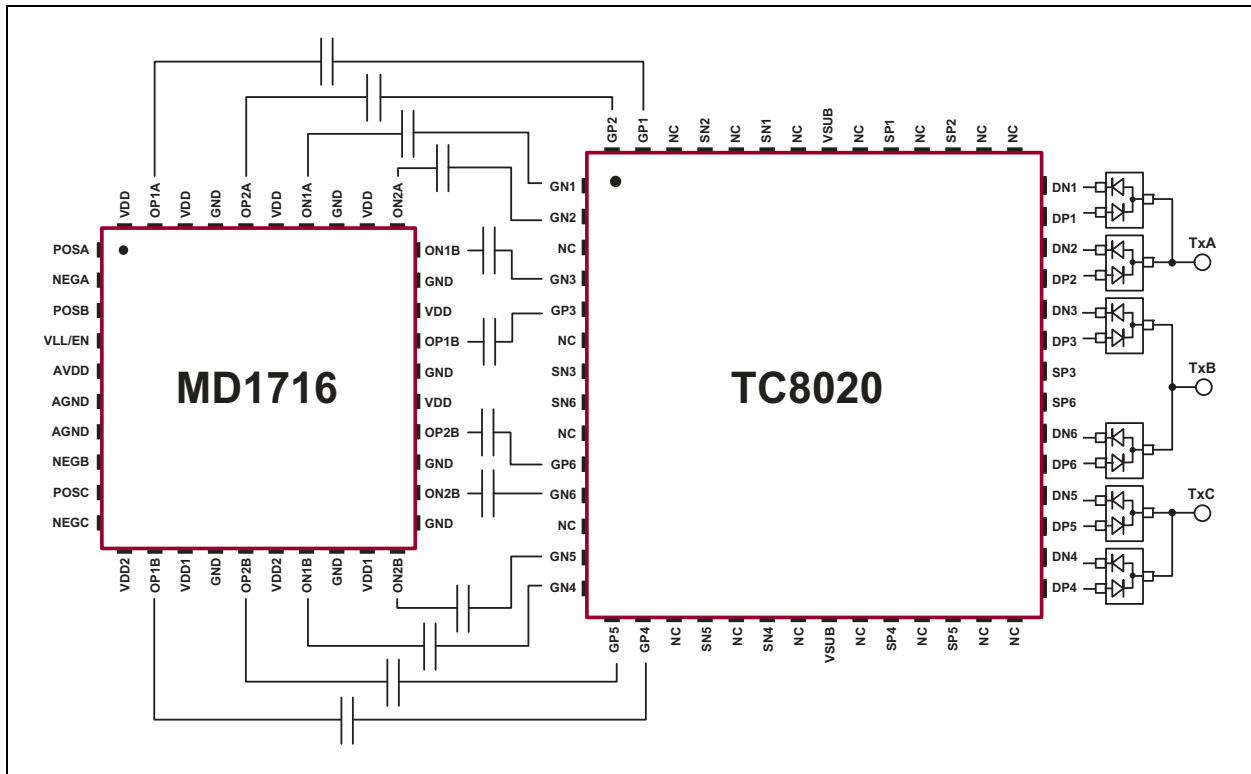


FIGURE 3-1: Circuit Pin Layout.

TABLE 3-1: TRUTH FUNCTION TABLE FOR CHANNEL A

EN	Logic Inputs A		SP1 to DP1	SN1 to DN1	SP2 to DP2	SN2 to DN2
	POSA	NEGA				
1	0	0	OFF	OFF	ON	ON
1	0	1	OFF	ON	OFF	OFF
1	1	0	ON	OFF	OFF	OFF
1	1	1	OFF	OFF	OFF	OFF

TABLE 3-2: TRUTH FUNCTION TABLE FOR CHANNEL B

EN	Logic Inputs B		SP3 to DP3	SN3 to DN3	SP6 to DP6	SN6 to DN6
	POSB	NEGB				
1	0	0	OFF	OFF	ON	ON
1	0	1	OFF	ON	OFF	OFF
1	1	0	ON	OFF	OFF	OFF
1	1	1	OFF	OFF	OFF	OFF

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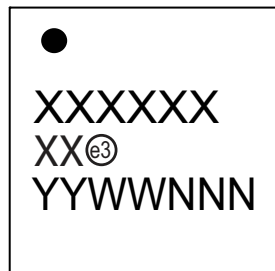
TABLE 3-3: TRUTH FUNCTION TABLE FOR CHANNEL B

EN	Logic Inputs C		SP5 to DP5	SN5 to DN5	SP4 to DP4	SN4 to DN4
	POSC	NEGC				
1	0	0	OFF	OFF	ON	ON
1	0	1	OFF	ON	OFF	OFF
1	1	0	ON	OFF	OFF	OFF
1	1	1	OFF	OFF	OFF	OFF
0	X	X	OFF	OFF	OFF	OFF
0→1	0	0	EN transitions from low to high or high to low should occur at all logic inputs low.			
1→0	0	0				

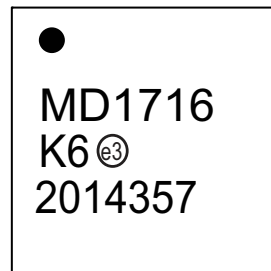
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

40-lead QFN



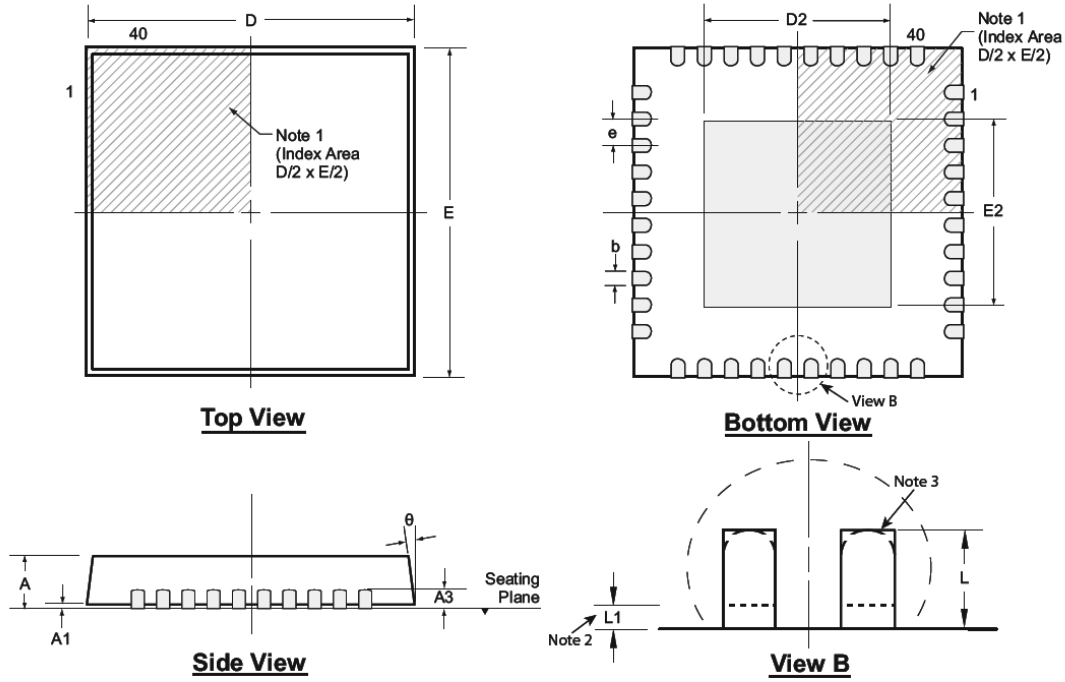
Example



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
	ⓔ3	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (ⓔ3) 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.	

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40-Lead QFN Package Outline (K6) 6.00x6.00mm 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	5.85*	1.05	5.85*	1.05	0.50 BSC	0.30 [†]	0.00	0
	NOM	0.90	0.02		0.25	6.00	-	6.00	-		0.40 [†]	-	-
	MAX	1.00	0.05		0.30	6.15*	4.45	6.15*	4.45		0.50 [†]	0.15	14

JEDEC Registration MO-220, Variation VJJD-6, Issue K, June 2006.

* This dimension is not specified in the JEDEC drawing.

† This dimension differs from the JEDEC drawing.

Drawings not to scale.

APPENDIX A: REVISION HISTORY

Revision A (October 2020)

- Converted Supertex Doc# DSFP-MD1716 to Microchip DS20005924A
- Changed the package marking format
- Removed the 40-lead VQFN K6 M935 media type
- Made minor text changes throughout the document

MD1716

PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>	<u>XX</u>	-	<u>X</u>	-	<u>X</u>
Device	Package Options		Environmental		Media Type
Device:	MD1716	=	3-Channel 3-Level High-Speed Ultrasound Driver IC		
Package:	K6	=	40-lead VQFN		
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package		
Media Types:	(blank)	=	490/Tray for a K6 Package		

Example:

a) MD1716K6-G: 3-Channel 3-Level High-Speed Ultrasound Driver IC, 40-lead VQFN, 490/Tray

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