

High-Side Power Switches

Features

- 1.7V to 5.5V Input Voltage Range
- · 1.2A Continuous Operating Current
- · 3A Pulse Current
- 120 mΩ R_{DS(ON)} (Typical)
- Built-In Level Shift for Control Logic; Can be Operated by 1.5V Logic
- Low 2 μA Quiescent Current
- Soft-Start: MIC94072/73
- Micropower Shutdown <1 μA
- Load Discharge Circuit: MIC94071, MIC94073
- Space Saving 1.2 mm x 1.6 mm UDFN Package

Applications

- · Load Switch in Portable Applications:
 - Cellular phones
 - PDAs
 - MP3 Players
 - Digital Cameras
 - Portable Instrumentation
- · Battery Switch-Over Circuits
- Level Translator

General Description

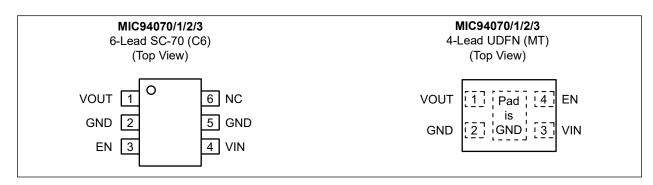
The MIC94070, MIC94071, MIC94072, and MIC94073 are high-side load switches designed for operation between 1.7V to 5.5V. The devices contain a low on-resistance P-channel MOSFET that supports 1.2A of continuous current. The MIC94071 and MIC94073 feature an active load discharge circuit that ensures capacitive loads retain no charge when the main switch is in an OFF state.

MIC94070 and MIC94071 feature rapid turn-on while MIC94072 and MIC94073 provide a slew rate controlled soft-start turn-on of 800 μ s (typical) to prevent in-rush current from glitching supply rails.

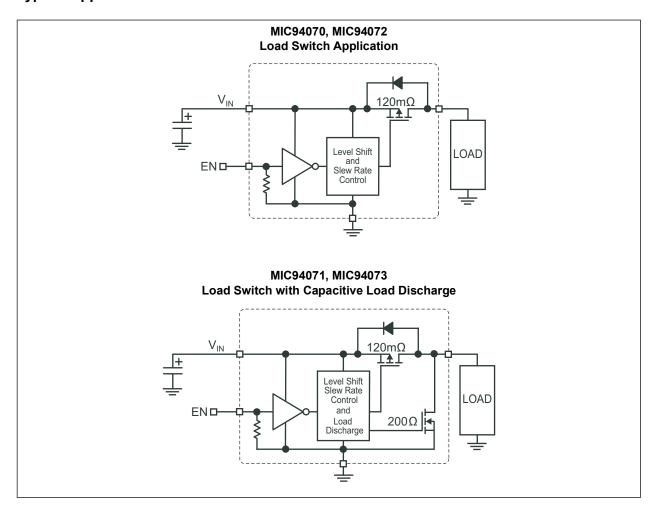
An active pull-down on the enable input keeps MIC94070/73 in a default OFF state until the EN pin is pulled to a high level. Built-in level shift circuitry allows low voltage logic signals to switch higher supply voltages, or vice versa; high level logic signals can control low level voltages.

MIC94070/73's operating voltage range makes them suitable for 1-cell Lithium ion and 2- to 3-cell NiMH/NiCad/Alkaline powered systems, as well as all 5V applications. Their low operating current of 2 μA and low shutdown current of <1 μA maximize battery life

Package Types



Typical Application Circuits



ELECTRICAL CHARACTERISTICS 1.0

Absolute Maximum Ratings †

Input Voltage (V _{IN})	+6V
Enable Voltage (V _{EN})	+6V
Continuous Drain Current (I _D , Note 1)	
UDFN (T _A = +25°C)	±1.2A
SC-70 (T _A = +25°C)	±1.2A
Pulsed Drain Current (I _{DP} , Note 2)	±3.0A
Continuous Diode Current (I _S , Note 3)	–50 mA
ESD Rating (HBM, Note 4)	4 kV
Operating Ratings ‡	

Input Voltage (V_{IN})+1.7V to +5.5V

† 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.

- **‡ Notice:** The device is not guaranteed to function outside its operating ratings.
 - Note 1: With backside thermal contact to PCB.
 - 2: Pulse width <300 µs with <2% duty cycle.
 - 3: Continuous body diode current conduction (reverse conduction, i.e. V_{OUT} to V_{IN}) is not recommended.
 - 4: Devices are ESD sensitive. Handling precautions recommended. HBM (Human body model), 1.5 k Ω in series with 100 pF.

ELECTRICAL CHARACTERISTICS

 $T_A = +25^{\circ}C$, **bold** values valid for $-40^{\circ}C \le T_A \le +125^{\circ}C$, unless noted.

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
Enable Threshold Voltage	\/	0.5	_	1.2	V	V_{IN} = 1.8V to 4.5V, I_{D} = -250 μ A
Chable Theshold Voltage	V _{EN_TH}	0.4		1.2	V	V_{IN} = 1.7V to 4.5V, I_{D} = -250 μ A
Supply Current	IQ		50 nA	5	μA	V _{IN} = V _{EN} = 5.5V, I _D = OPEN Measured on the VIN pin, Note 1
Enable Input Current	I _{EN}	_	2	4	μA	$V_{IN} = V_{EN} = 5.5V$, $I_D = OPEN$
Shutdown Current	I _{SHUT-Q}		25 nA	1	μA	V _{IN} = +5.5V, V _{EN} = 0V, I _D = OPEN Measured on the VIN pin, Note 1
OFF State Leakage Current	I _{SHUT-SWITCH}	_	50 nA	1	μA	V _{IN} = +5.5V, V _{EN} = 0V, I _D = SHORT, Measured on VOUT, Note 1
		_	120	170	mΩ	V_{IN} = +5.0V, I_{D} = -100 mA, V_{EN} = 1.5V
P-Channel Drain-to-Source ON		_	130	185	mΩ	V_{IN} = +4.5V, I_{D} = -100 mA, V_{EN} = 1.5V
Resistance	P	_	145	210	mΩ	V_{IN} = +3.6V, I_{D} = -100 mA, V_{EN} = 1.5V
00.70.0	R _{DS(ON)}	_	165	225	mΩ	V_{IN} = +2.5V, I_{D} = -100 mA, V_{EN} = 1.5V
SC-70 Package			200	260	mΩ	$V_{IN} = +1.8V$, $I_D = -100$ mA, $V_{EN} = 1.5V$
		_	210	285	mΩ	V _{IN} = +1.7V, I _D = -100 mA, V _{EN} = 1.5V

ELECTRICAL CHARACTERISTICS (CONTINUED)

 T_A = +25°C, **bold** values valid for -40°C ≤ T_A ≤ +125°C, unless noted.

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
		_	100	160	mΩ	$V_{IN} = +5.0V$, $I_D = -100$ mA, $V_{EN} = 1.5V$
P-Channel Drain-to-Source ON		_	110	165	mΩ	V _{IN} = +4.5V, I _D = -100 mA, V _{EN} = 1.5V
Resistance	R _{DS(ON)}	_	125	180	mΩ	V_{IN} = +3.6V, I_{D} = -100 mA, V_{EN} = 1.5V
		_	145	200	mΩ	V _{IN} = +2.5V, I _D = -100 mA, V _{EN} = 1.5V
UDFN Package		_	180	240	mΩ	V _{IN} = +1.8V, I _D = -100 mA, V _{EN} = 1.5V
		_	190	265	mΩ	$V_{IN} = +1.7V$, $I_{D} = -100$ mA, $V_{EN} = 1.5V$
Load Discharge Resistance (MIC94071, MIC94073)	R _{DISCHARGE}		200	400	Ω	V_{IN} = +3.6V, I_{TEST} = 1 mA, V_{EN} = 0V

Note 1: Measured on the MIC94070YMT, for other part numbers, please contact Microchip.

ELECTRICAL CHARACTERISTICS (DYNAMIC)

 V_{IN} = 5V, T_A = +25°C, **bold** values valid for –40°C ≤ T_A ≤ +125°C, unless noted.

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
Turn-On Delay Time	4.	_	0.85	1.5	μs	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94070, 71
Turn-On Delay Time	ton_dly	_	700	1200	μs	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94072, 73
Turn-On Rise Time	t	0.5	1	5	μs	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94070, 71
Turr-Off Rise Time	ton_rise	500	800	1500	μs	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94072, 73
Turn Off Doloy Time	t _{OFF_DLY}	_	100	200	ns	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94070, 71
Turn-Off Delay Time		_	60	200	ns	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94072, 73
Turn-Off Fall Time	t _{OFF_FALL}	_	60	100	ns	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94070, 71
		_	60	100	ns	V _{IN} = +3.6V, I _D = -100 mA, V _{EN} = 1.5V, MIC94072, 73

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Тур.	Max.	Units	Conditions			
Temperature Ranges									
Storage Temperature Range	T _S	-55	_	+150	°C	_			
Junction Temperature Range	T_J	-40	_	+125	°C	_			
Package Thermal Resistances									
Thermal Resistance, SC-70 6-Ld	θ_{JA}	_	240	_	°C/W	_			
Thermal Resistance, UDFN 8-Ld	θ_{JA}	_	172	_	°C/W	_			
THEITHAL NESISTAILE, UDFN 0-LU	θ_{JC}	_	134	_	°C/W	Note 1			

Note 1: With backside thermal contact to PCB.

2.0 TYPICAL PERFORMANCE CURVES

The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

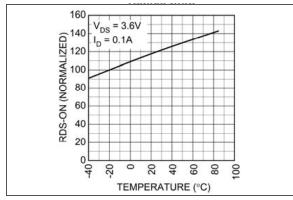
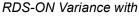


FIGURE 2-1: Temperature.

Note:



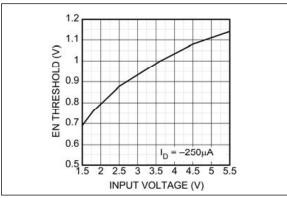


FIGURE 2-2: Input Voltage.

EN Threshold Voltage vs.

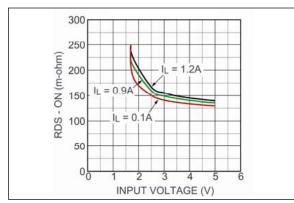


FIGURE 2-3: Voltage.

On Resistance vs. Input

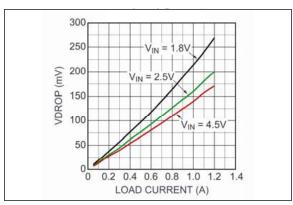


FIGURE 2-4: Current.

E 2-4: Voltage Drop vs. Load

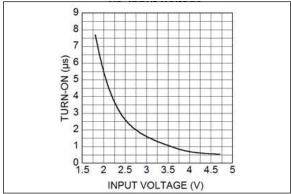


FIGURE 2-5: MIC94070/71 Turn-On Delay vs. Input Voltage.

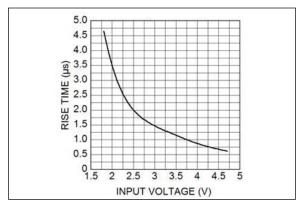
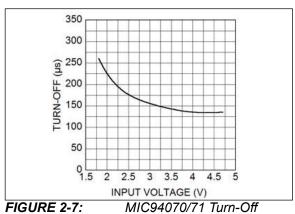


FIGURE 2-6: Input Voltage.

MIC94070/71 Rise Time vs.



Delay vs. Input Voltage.

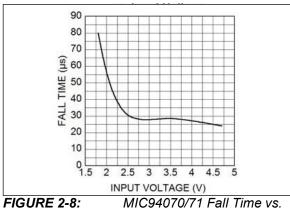


FIGURE 2-8: Input Voltage.

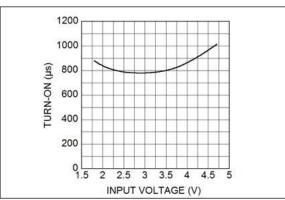


FIGURE 2-9: MIC94072/73 Turn-On Delay vs. Input Voltage.

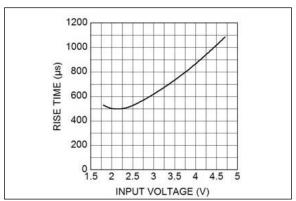
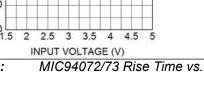


FIGURE 2-10: Input Voltage.



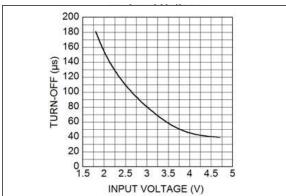
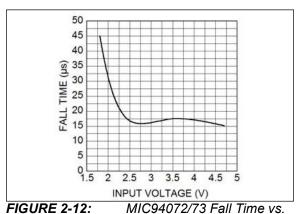


FIGURE 2-11: MIC94072/73 Turn-Off Delay vs. Input Voltage.



Input Voltage.

MIC94070

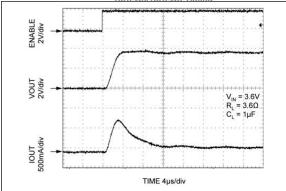
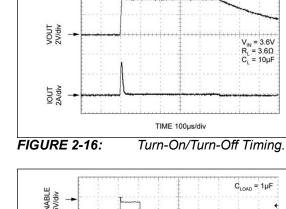


FIGURE 2-13: Turn-On/Turn-Off Timing.



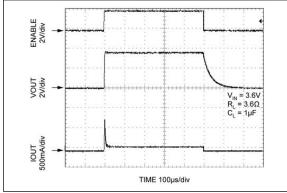
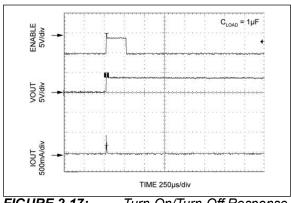
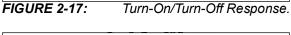


FIGURE 2-14: Turn-On/Turn-Off Timing.





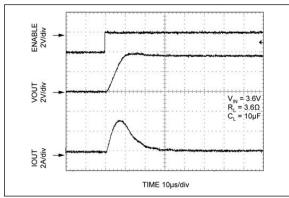


FIGURE 2-15: Turn-On/Turn-Off Timing.

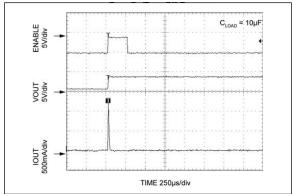


FIGURE 2-18: Turn-On/Turn-Off Response.

MIC94071

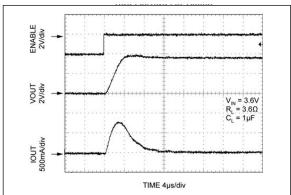


FIGURE 2-19: Turn-On/Turn-Off Timing.

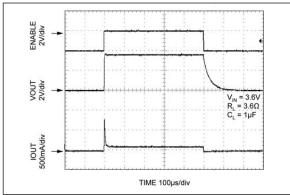


FIGURE 2-20: Turn-On/Turn-Off Timing.

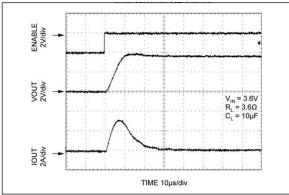


FIGURE 2-21: Turn-On/Turn-Off Timing.

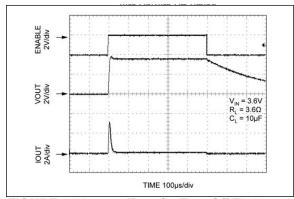


FIGURE 2-22: Turn-On/Turn-Off Timing.

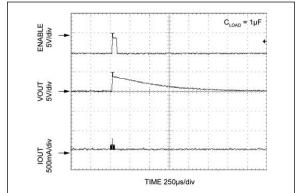


FIGURE 2-23: Turn-On/Turn-Off Response.

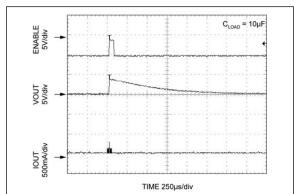


FIGURE 2-24: Turn-On/Turn-Off Response.

MIC94072

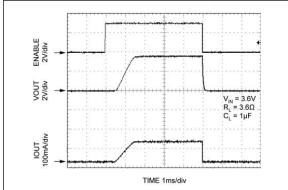


FIGURE 2-25: Turn-On/Turn-Off Timing.

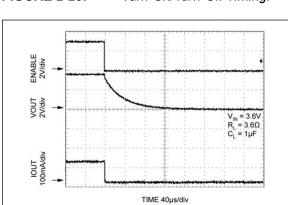


FIGURE 2-26: Turn-On/Turn-Off Timing.

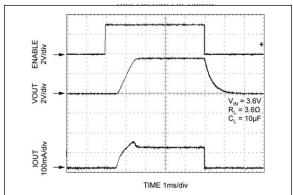


FIGURE 2-27: Turn-On/Turn-Off Timing.

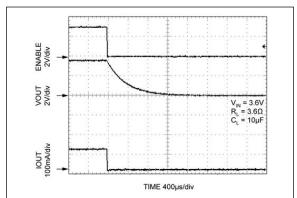


FIGURE 2-28: Turn-On/Turn-Off Timing.

MIC94073

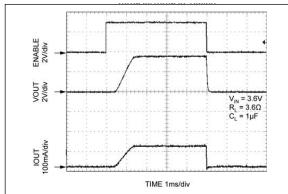


FIGURE 2-29:

Turn-On/Turn-Off Timing.

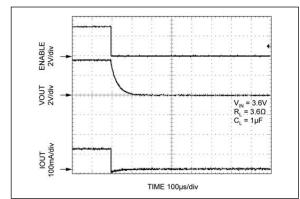


FIGURE 2-30:

Turn-On/Turn-Off Timing.

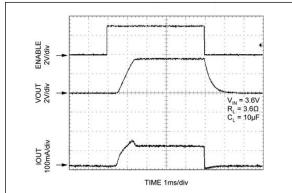


FIGURE 2-31:

Turn-On/Turn-Off Timing.

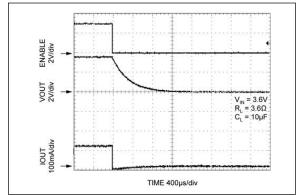


FIGURE 2-32:

Turn-On/Turn-Off Timing.

3.0 PIN DESCRIPTIONS

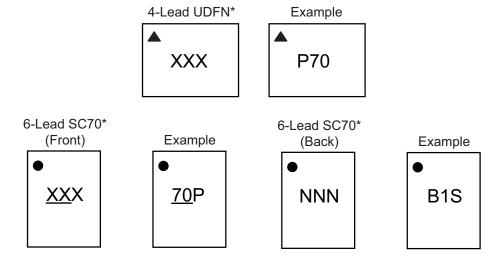
The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number SC-70	Pin Number UDFN	Pin Name	Description
1	1	VOUT	Drain of P-channel MOSFET.
2, 5	2	GND	Ground and the backside pad (UDFN only) should both be connected to electrical ground.
4	3	VIN	Source of P-channel MOSFET.
3	4	EN	Enable (Input): Active-high CMOS compatible control input for switch A. Do not leave floating.
6	_	NC	No Internal Connection. A signal or voltage applied to this pin will have no effect on device operation.

4.0 PACKAGING INFORMATION

4.1 **Package Marking Information**



Legend: XX...X Product code or customer-specific information Year code (last digit of calendar year) ΥY Year code (last 2 digits of calendar year) WW Week code (week of January 1 is week '01') Alphanumeric traceability code NNN Pb-free JEDEC® designator for Matte Tin (Sn) (e3) This package is Pb-free. The Pb-free JEDEC designator (@3) can be found on the outer packaging for this package. •, ▲, ▼ Pin one index is identified by a dot, delta up, or delta down (triangle

mark).

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 customer-specific information. Package may or may not include the corporate logo.

Underbar () and/or Overbar () symbol may not be to scale.

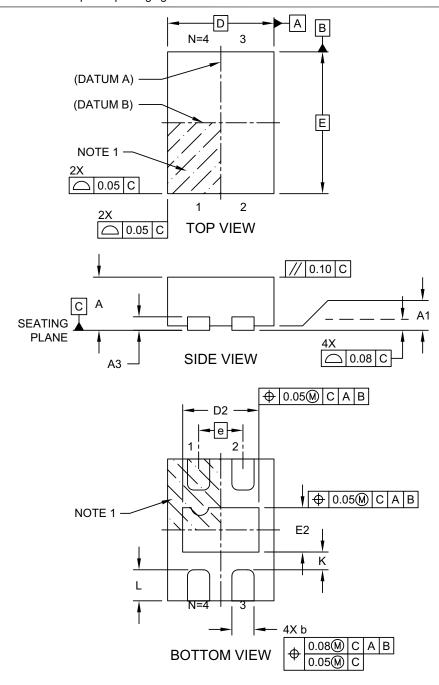
If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are Note: used based on the available marking space:

6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;

2 Characters = NN; 1 Character = N

4-Lead Ultra Thin Dual Flat, No Lead Package (HGA) - 1.2x1.6x0.6 mm Body [UDFN] Micrel Legacy Package TMLF1216D-04L

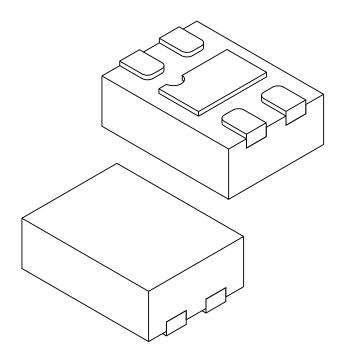
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1152 Rev A Sheet 1 of 2

4-Lead Ultra Thin Dual Flat, No Lead Package (HGA) - 1.2x1.6x0.6 mm Body [UDFN] Micrel Legacy Package TMLF1216D-04L

lote: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



	Units	MILLIMETERS				
Dimension	Limits	MIN	NOM	MAX		
Number of Terminals	N	4				
Pitch	е		0.50 BSC			
Overall Height	Α	0.50	0.55	0.60		
Standoff	A1	0.00	0.05			
Terminal Thickness	A3		0.152 REF			
Overall Length	D		1.20 BSC			
Exposed Pad Length	D2	0.81	0.86	0.91		
Overall Width	Е		1.60 BSC			
Exposed Pad Width	E2	0.45	0.50	0.55		
Terminal Width	b	0.20 0.25 0.30				
Terminal Length	Ĺ	0.30	0.35	0.40		
Terminal-to-Exposed-Pad	K	0.20	-	_		

Notes:

- 1. Pin 1 visual index feature may vary, but must be located within the hatched area.
- 2. Package is saw singulated
- 3. Dimensioning and tolerancing per ASME Y14.5M

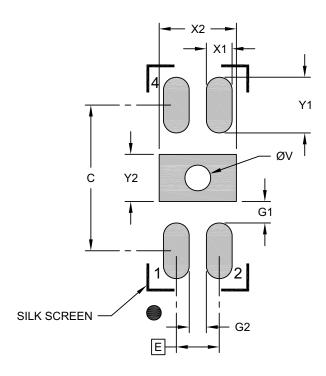
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1152 Rev A Sheet 2 of 2

4-Lead Ultra Thin Dual Flat, No Lead Package (HGA) - 1.2x1.6x0.6 mm Body [UDFN] Micrel Legacy Package TMLF1216D-04L

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



RECOMMENDED LAND PATTERN

	MILLIMETERS				
Dimension	MIN	NOM	MAX		
Contact Pitch	E		0.50 BSC		
Optional Center Pad Width	X2	0.9			
Optional Center Pad Length	Y2			0.55	
Contact Pad Spacing	С		1.70		
Contact Pad Width (X4)	X1			0.30	
Contact Pad Length (X4)	Y1			0.65	
Contact Pad to Center Pad (X4)	G1	0.25			
Contact Pad to Contact Pad (X2)	G2	0.20			
Thermal Via Diameter	V		0.30		

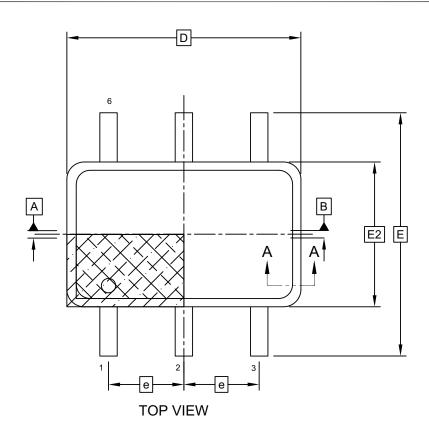
Notes:

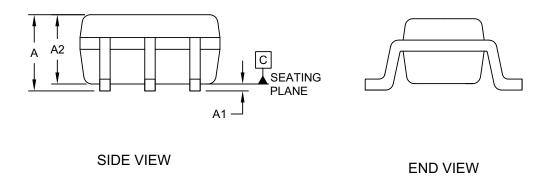
- Dimensioning and tolerancing per ASME Y14.5M
 BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- 2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3152 Rev A

6-Lead Plastic package, EIAJ standard (D4A) - 2.0x1.25 mm Body [SC70] Micrel Legacy Package

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

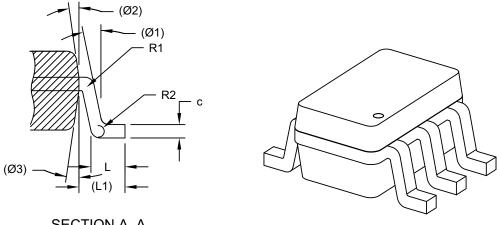




Microchip Technology Drawing C04-1133 Rev A Sheet 1 of 2

6-Lead Plastic package, EIAJ standard (D4A) - 2.0x1.25 mm Body [SC70] **Micrel Legacy Package**

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



	MILLIMETERS				
Din	MIN	NOM	MAX		
Number of Terminals	N		6		
Pitch	е		0.65 BSC		
Overall Height	Α	-	-	1.10	
Standoff	A1	0.00	-	0.10	
Molded Package Thickness	A2	0.80	_	1.00	
Overall Length	D		2.00 BSC		
Overall Width	Е		2.10 BSC		
Molded Package Width	E2		1.25 BSC		
Terminal Width	b	0.15	_	0.30	
Terminal Thickness	С	0.08	-	0.25	
Terminal Length	L	0.21	_	0.46	
Footprint	L1		0.55 REF		
Lead Bend Radius	R1	0.02	-	0.08	
Lead Bend Radius	0.08	-	0.20		
Lead Angle	θ1	12° REF			
Mold Draft Angle	θ2	8° REF			
Mold Draft Angle	θ3	8° REF			

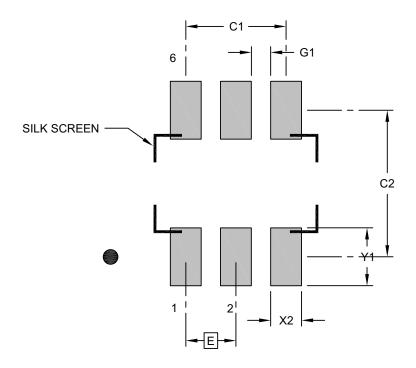
Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
 Dimensioning and tolerancing per ASME Y14.5M
- - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
 - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1133 Rev A Sheet 2 of 2

6-Lead Plastic package, EIAJ standard (D4A) - 2.0x1.25 mm Body [SC70] Micrel Legacy Package

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



RECOMMENDED LAND PATTERN

	Units	MILLIMETERS			
Dimension	MIN	MAX			
Contact Pitch	Е	E 0.65 BSC			
Contact Pad Spacing	C1		1.30		
Contact Pad Spacing	C2		1.90		
Contact Pad Width (X6)	X1			0.42	
Contact Pad Length (X6)	Y1			0.77	
Contact Pad to Contact Pad (X4)	G1	0.25			

Notes:

- Dimensioning and tolerancing per ASME Y14.5M
 BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- 2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2133 Rev A

APPENDIX A: REVISION HISTORY

Revision A (May 2024)

- Converted Micrel document MIC94070/1/2/3 to Microchip data sheet DS20006896A.
- Minor text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

Part Number	x		į	X	[- <u>XX]</u>	Examples:		
Device	Temperatur	e R	ange Pac	ekage	Media Type	a) MIC94070	YC6-TR:	MIC94070, -40°C to +125°C Temp. Range, 6-Lead SC70, 5,000/Reel
Device:	MIC94070: MIC94071:		High-Side Power Switch High-Side Power Switch and Load Discharge		h Fast Turn-On	b) MIC94070	YMT-TR:	MIC94070, -40°C to +125°C Temp. Range, 4-Lead UDFN, 3,000/Reel
	MIC94072: MIC94073:				h Soft-Start and	c) MIC94071	YC6-TR:	MIC94071, -40°C to +125°C Temp. Range, 6-Lead SC70, 5,000/Reel
Temperature Range:	Y	=	-40°C to +129	5°C		d) MIC94071	YMT-TR:	MIC94071, -40°C to +125°C Temp. Range, 4-Lead UDFN, 3,000/Reel
Package:	C6 MT	=	6-Lead SC70 4-Lead UDFN			e) MIC94072	YC6-TR:	MIC94072, -40°C to +125°C Temp. Range, 6-Lead SC70, 5,000/Reel
Media Type:	TR TR	=	5,000/Reel (S	C70 option on		f) MIC94072	YMT-TR:	MIC94072, -40°C to +125°C Temp. Range, 4-Lead UDFN, 3,000/Reel
			3,000/Neer (0	DI N OPHOITOI		g) MIC94073	YC6-TR:	MIC94073, -40°C to +125°C Temp. Range, 6-Lead SC70, 5,000/Reel
						h) MIC94073	YMT-TR:	MIC94073, -40°C to +125°C Temp. Range, 4-Lead UDFN, 3,000/Reel
						Note:	catalog points used printed of your Micro	I Reel identifier only appears in the art number description. This identifier for ordering purposes and is not on the device package. Check with ochip Sales Office for package available the Tape and Reel option.

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