MTA41110

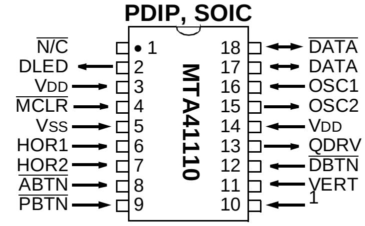
PS/2® Mouse and Trackball Controller I.C.

FEATURES

- Single-chip two-button mouse or trackball controller
- 10 kHz IBM® PS/2 interface
- IBM PS/2 mouse compliant
- Selectable Mouse or Trackball resolutions
- Strobed motion encoders for reduced system power consumption
- Motion sampling rate of 8700 Samples/second
- Proprietary anti-jitter algorithm simplifies motion encoder interface
- Available In:
  - 18-lead 300 mil PDIP
  - 18-lead 300 mil SOIC

PIN CINFIGURATIONS

PDIP, SOIC



DESCRIPTION

The MTA41110 is the heart of a simple, low-cost, mouse or trackball solution. It can be configured to operate as an IBM PS/2 compliant mouse or trackball controller. The mouse select and drag operation can be accomplished with a trackball by using the optional drag lock input and drag lock LED. This allows for one handed select and drag operation when using a track-ball.

MTA41110

The MTA41110 is an 18-lead low-power CMOS integrated circuit. Combined with a few simple external components, a complete mouse or trackball system can be realized.

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1.0 PIN DESCRIPTIONS

PIN NAME	TYPE	DESCRIPTION
NC	No Connect	This pin should be left unconnected
QDRV	Output	Active high strobed encoder drive
HOR1	Input	Horizontal quadrature input #1
HOR2	Input	Horizontal quadrature input #2
$\overline{\text{PBTN}}$	Input	Primary mouse button. Active low , 0 = button depressed
$\overline{\text{ABTN}}$	Input	Alternate mouse button. Active low, 0 = button depressed
$\overline{\text{DBTN}}$	Input	Optional trackball drag lock button. Active low, 0 = button depressed. For mouse operation connect this pin to V_{DD}
VERT1	Input	Vertical quadrature input #1
VERT2	Input	Vertical quadrature input #2
$\overline{\text{DLED}}$	Output	Optional trackball drag LED. For mouse operation this pin is a no connect and should be left unconnected
OSC1	Input	4 MHz crystal or ceramic resonator connection
OSC2	Output	4 MHz crystal or ceramic resonator connection
DATA	I/O	Bi-directional data port for PS/2
CLK	Input	PS/2 data clock input
$\overline{\text{MCLR}}$	Input	A “low” voltage on this pin causes a reset condition for the MTA41110 controller
V_{DD}	Pwr	+5V
V_{SS}	Pwr	Ground

2.0 OPERATION

Upon power-up, the MTA41110 mouse controller initiates an internal reset sequence. First, all internal registers and communication parameters are cleared. Next, the status registers are set to the default condition. Finally, if the MTA41110 receives a Resend command as the first command after power-up, it will transmit a AAh followed by a 00h in response. This notifies the host that the initialization is complete and that the controller is a standard mouse type. This is to ensure compatibility with some hosts that do not follow the normally recommended behavior of issuing a Reset command as the first command after power-up.

The MTA41110 always confirms reception of a command sent by the host by returning an acknowledge byte (FAh). If the host interrupts the transmission of the acknowledge byte, the MTA41110 discards the complete command. The MTA41110 is then ready to receive and acknowledge the next command. Two exceptions to the acknowledge after command received rule exist. The MTA41110 does not issue an acknowledge upon receipt of either the Set Wrap Mode (EEh) or Resend (FEh) commands.

2.1 PS/2 COMMANDS

Command Summary:

Command	Code, Data
Reset	FFh
Resend	FEh
Set Default	F6h
Disable Reporting	F5h
Enable Reporting	F4h
Set Report Rate	F3h , XXh
Read Device Type	F2h
Set Remote Mode	F0h
Set Wrap Mode	EEh
Reset Wrap Mode	ECh
Read Data	EBh
Set Stream Mode	EAh
Status Request	E9h
Set Resolution	E8h , XXh
Set Scaling	E7h
Reset Scaling	E6h

2.1.1 RESET CODE: FFH

This command initiates a reset sequence in the MTA41110 mouse controller. First, all internal registers and communication parameters are cleared. Next, the status registers are set to the default condition. Finally, the MTA41110 transmits a AAh followed by a 00h, this informs the host that the initialization is complete and that the controller is a standard mouse type.

2.1.2 RESEND CODE: FEH

Anytime the MTA41110 controller receives an invalidly formatted command, it will transmit a Resend command to the host. The controller will ignore invalid commands and will continue to operate in its present mode. When any command other than a Resend is received by the controller it will clear its motion and displacement counters.

The host system may send a Resend command to the controller if an error is detected in a transmission from the controller. When the controller receives a Resend command, it will retransmit the last data packet transmitted. If the last packet transmitted was a Resend command, the packet prior to the last packet will be re-transmitted.

2.1.3 SET DEFAULT CODE: F6H

The Set Default command re-initializes all controller parameters to the power-up state. The controller initializes the following status registers.

Report rate:	100 reports per second
Scaling:	Linear
Mode:	Streaming
Resolution:	Physical Resolution / 2
Reporting:	Disabled

This command does not initiate any self-test diagnostics. The controller remains in the disabled state until another command is received from the host.

2.1.4 DISABLE REPORTING CODE: F5H

The Disable Reporting command prevents data transmission by the controller while it is in the Stream Mode. However, the controller will still respond to other commands. When reporting is disabled, Stream Mode must be disabled prior to the host sending a command that requires a response by the controller.

2.1.5 ENABLE REPORTING CODE: F4H

The Enable Reporting command allows the controller to transmit data when in Stream Mode. This command has no effect while the controller is in Remote Mode.

2.1.6 SET REPORT RATE CODE: F3H , XXH

This command updates the report rate status register with the data contained in the second byte of the command. However, the physical report rate remains fixed at 40 times per second. This command only exists to ensure compatibility.

2.1.7 READ DEVICE TYPE CODE: F2H

The controller always transmits a 00h in response to receiving this command. This informs the host that a standard mouse is present.

2.1.8 SET REMOTE MODE CODE: F0H

Remote Mode is entered when the controller receives this command. In Remote Mode, event packets are transmitted to the host only when a read data command is received by the controller.

2.1.9 SET WRAP MODE CODE: EEH

Wrap Mode is entered when the controller receives this command. In Wrap Mode, the controller will echo all commands that are received back to the host. Note, the Reset and Reset Wrap commands will cancel Wrap Mode and neither of these commands will be echoed back to the host. Wrap Mode can be enabled in either Reporting Mode, Stream Mode or Remote Mode.

2.1.10 RESET WRAP MODE CODE: ECH

This command cancels Wrap Mode. The controller remains in the current Reporting Mode. Note, if the controller enters Wrap Mode while in Stream Mode and then a Reset Wrap Mode command is received, the controller will reenter the Stream Mode with Wrap Mode disabled.

2.1.11 READ DATA CODE: EBH

The controller will transmit an event packet to the host after a read data command is received. This command can be issued in either the Remote or Stream Modes. The controller will transmit data even if there has not been any button changes or motion since the last report. The controller clears the motion counters after ever read data command.

2.1.12 SET STREAM MODE CODE: EAH

The controller will enter the Stream Mode upon receiving this command. In Stream Mode, event packets are transmitted to the host as they occur.

2.1.13 STATUS REQUEST CODE: E9H

A three byte status report packet will be transmitted in response to this command. These status bytes are defined as follows:

Byte 1:

Bit	Description
0	1 = Secondary Button Depressed
1	Reserved
2	1 = Primary Button Depressed
3	Reserved
4	1 = 2:1 Scaling
5	1 = Enabled
6	1 = Remote Mode
7	Reserved

Byte 2: Current Resolution

Byte 3: Current Sample Rate

2.1.14 SET RESOLUTION CODE: E8H, XXH

The controller provides four resolutions selected by the second byte of this command. The effective resolution is the physical device resolution divided by the divisor indicated below.

Second Byte	Description
0	divide by 8
1	divide by 4
2	divide by 2
3	divide by 1

2.1.15 SET SCALING CODE: E7H

This command has no effect on resolution and only exists to ensure compatibility.

2.1.16 RESET SCALING CODE: E6H

This command resets the scaling to 1:1 (input count equals reported count).

2.2 PS/2 Message Data Format

The following PS/2 compliant data format is used by the MTA41110 when transmitting data to the host and when receiving data from the host. The data format utilizes an 11-bit data frame that utilizes 8-bits for message data and 3-bits for control.

Data Frame Format:

Bit	Description
1	Start Bit (always 0)
2	Message Data Bit0 , LSB
3	Message Data Bit1
4	Message Data Bit2
5	Message Data Bit3
6	Message Data Bit4
7	Message Data Bit5
8	Message Data Bit6
9	Message Data Bit7 , MSB
10	Parity Bit (odd parity)
11	Stop bit (always 1)

The MTA41110 mouse controller transmits the following three byte data packet in response to a Read Data (EBh) command or when operating in Stream Mode with reporting enabled.

Status Message Data Byte 1:

Bit	Description
0	1 = Primary Button Depressed
1	1 = Secondary Button Depressed
2	Reserved
3	Reserved
4	X data sign, 1 = negative
5	Y data sign, 1 = negative
6	X data overflow, 1 = overflow
7	Y data overflow, 1 = overflow

Status Message Data Byte 2:

Delta X motion

Status Message Data Byte 3:

Delta Y motion

3.0 MOTION ENCODER INTERFACE

The MTA41110 is designed to interface to both optical encoders that utilize LED and photo transistor pairs with a chopper wheel or mechanical encoders that utilize a commutator with wiper contacts.

Power consumption is reduced by strobing the motion encoder power each time the encoders are sampled. The MTA41110 will drive the QDRV output high 8 µS (with 4 MHz input clock) prior to sampling the HOR and VERT inputs to give the encoders time to stabilize. The QDRV output will be driven back low 2 µs after the sample is taken. If power consumption is not a concern, then the QDRV output can be left unconnected and encoders can be powered directly from a constant supply (e.g., +5V power).

An anti-jitter algorithm is employed to eliminate false motion counting when the mouse or trackball is not moving. This is especially useful in designs employing optical encoders since the output of an optical detector is an analog signal. The anti-jitter algorithm eliminates false counting when a voltage that is not a well defined logic low or logic high is applied to either the HOR or VERT inputs.

The HOR and VERT inputs detect positive and negative delta motion. Motion direction is defined in the following state table along with Figure 3-1 and Figure 3-2.

Positive Motion:

Hor1,Hor2 / Vert1,Vert2	Description
0,0	
0,1	
1,1	Positive Direction Sequence
1,0	
0,0	
etc.	

Negative Motion:

Hor1,Hor2 / Vert1,Vert2	Description
0,0	
1,0	
1,1	Negative Direction Sequence
0,1	
0,0	
etc.	

The HOR and VERT inputs are sampled at ~8700 samples per second with a 4 MHz input clock. The sample rate will decrease slightly when communication traffic to or from the host is occurring. The sample rate is directly proportional to the clock frequency on the OSC1 and OSC2 pins.

FIGURE 3-1: POSITIVE MOTION SEQUENCE

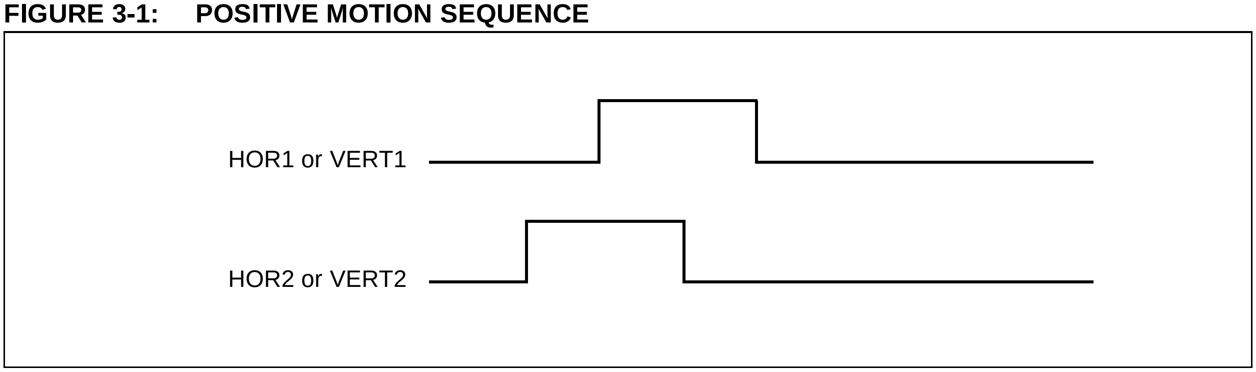
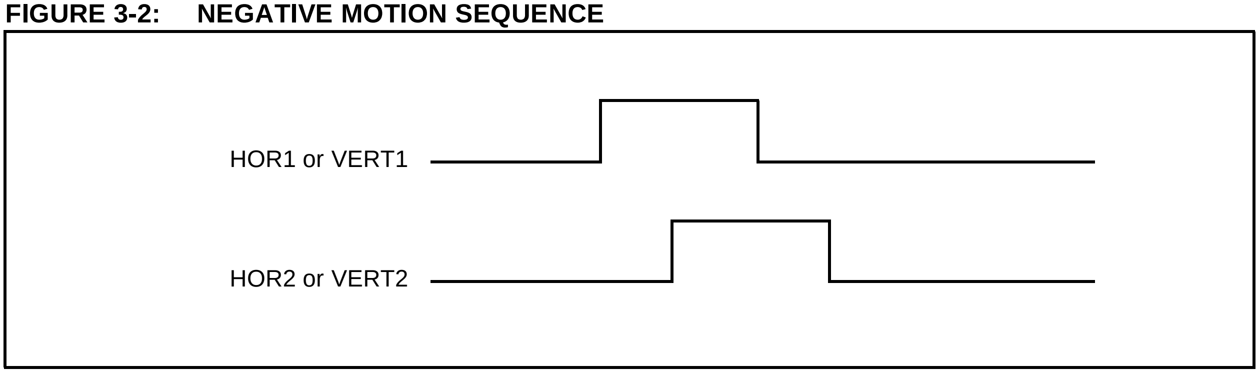


FIGURE 3-2: NEGATIVE MOTION SEQUENCE



4.0 PUSH-BUTTON INPUTS

The MTA41110 push-button inputs are defined to be active when the input pin is in the low state. The appropriate message data bit will be set equal to one when a low is sampled at a switch input. When a switch input is sampled in the high state, the appropriate message data bit will be set equal to zero.

5.0 TRACKBALL OPTION

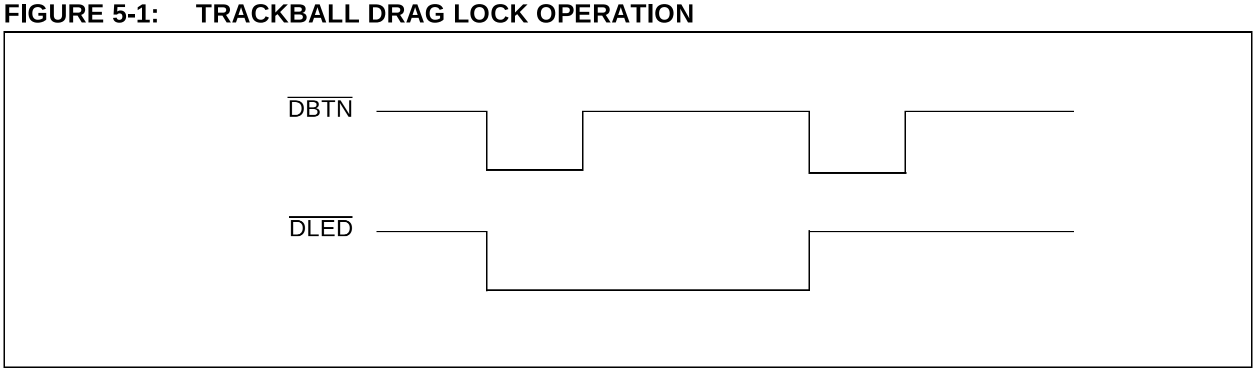
The MTA41110 can also function as a trackball controller. A trackball drag lock switch can be connected to the $\overline{\text{DBTN}}$ input and an LED indicator connected to the $\overline{\text{DLED}}$ output to aid in one-handed trackball operation.

When using a mouse, a select and drag operation is performed by clicking on an object and holding the primary mouse button down. Moving the mouse then drags the object to the desired location. When the primary button is released the object is placed at the desired location. However, when the same select and drag operation is performed using a trackball, it may be difficult to hold the button depressed and guide the trackball with the same hand.

The MTA41110's "drag lock" feature allows this function to be accomplished with one hand. The drag lock is set to the "locked" state by momentarily applying a low to the $\overline{\text{DBTN}}$ input. This "locked" state is equivalent to depressing and holding the primary mouse button. The user then guides the object to the desired location without having to hold a button depressed and simultaneously guide the trackball. The object is placed and the "lock" is released when a low (e.g., button depressed) is momentarily applied to any button input.

The $\overline{\text{DLED}}$ output is latched in the low state (0V) when the DBTN input is sampled low (Figure 5-1). The $\overline{\text{DLED}}$ output will remain low ("locked") until the DBTN input is sampled high and then sampled low again. Exiting the locked state also occurs if the $\overline{\text{PBTN}}$ input or SBTN input is sampled low when the $\overline{\text{DLED}}$ output is low. When the $\overline{\text{DLED}}$ output is in low "locked" state, the Primary Button depressed bit in the status message is set high.

FIGURE 5-1: TRACKBALL DRAG LOCK OPERATION



6.0 ELECTRICAL CHARACTERISTICS

6.1 Absolute Maximum Ratings †

Ambient temperature under bias .... -55°C to +125°C

Storage temperature .... -65°C to +150°C

Voltage on any pin with respect to V_{SS} (except V_{DD} and $\overline{MCLR}$) .... -0.6V to (V_{DD} +0.6V)

Voltage on $\overline{MCLR}$ pin with respect to V_{SS} .... 0V to +14.0V

Voltage on V_{DD} with respect to V_{SS} .... 0V to +9.5V

Total power dissipation (Note 2) .... 800 mW

Maximum current out of V_{SS} pin .... 150 mA

Maximum current into V_{DD} pin .... 50 mA

Maximum current into input pin .... ±500 µA

Maximum output current sinked by any I/O or output pin .... 25 mA

Maximum output current sourced by any I/O or output pin .... 20 mA

Notes:

1. Voltage spikes below V_{SS} at the $\overline{MCLR}$ pin, inducing currents greater than 80 mA may cause latch-up. Thus, a series resistor of 50-100 Ω should be used when applying a “low” level to this pin, rather than connecting this pin directly to V_{SS}.
2. Total power dissipation should not exceed 800 mW for the package. The total power dissipation is calculated as follows: $P_{DIS} = V_{DD} \times (I_{DD} - \sum I_{OH}) + \sum\{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum(V_{OL} \times I_{OL})$.

† 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 operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

6.2 DC CHARACTERISTICS MTA41110 (COMMERCIAL)

Standard Operating Conditions (unless otherwise stated).
Operating Temperature 0°C < T_A < 70°C for commercial.
Operating voltage V_{DD} = 3.0V to 5.5V unless otherwise stated.

Characteristic	SyM.	Min.	Typ.	Max	Units	Conditions
Supply Voltage	V_{DD}	3.0		6.25	V	F_{OSC} = DC to 4 MHz
V_{DD} start voltage to guarantee power on reset	V_{POR}		V_{SS}		V	
V_{DD} rise rate to guarantee power on reset	SV_{DD}	0.05			V/mS	
Supply Current	I_{DD}		1.8	3.3	mA	F_{OSC} = 4 MHz , V_{DD} = 5.5V
Input Low Voltage						
$\overline{MCLR}$ (Schmitt trigger)	V_{ILMC}			.15V_{DD}	V	
OSC1 (Schmitt trigger)	V_{ILOSC}			.3V_{DD}	V	
All other Inputs	V_{IL}			.2V_{DD}	V	
Input High Voltage						
MCLR (Schmitt trigger)	V_{IHMC}	.85 V_{DD}		V_{DD}	V	
OSC1 (Schmitt trigger)	V_{IHOSC}	.7 V_{DD}		V_{DD}	V	
All other Inputs	V_{IH}	.45 V_{DD}		V_{DD}	V	
		2 V		V_{DD}	V	4.0V < V_{DD} ≤ 5.5V
Input Leakage Current						
$\overline{MCLR}$	I_{ILMCL}	-5			µA	V_{PIN} = V_{DD} + 0.25V
$\overline{MCLR}$	I_{ILMCH}		0.5	+5	µA	V_{PIN} = V_{DD}
OSC1 (Schmitt trigger)	I_{ILMCH}		0.5	+3	µA	V_{DD} ≤ V_{PIN} ≤ V_{DD}
All other Inputs	I_{IL}	-1	0.5	+1	µA	V_{DD} ≤ V_{PIN} ≤ V_{DD}
Output Low Voltage						
OSC2	V_{OL}			0.6	V	I_{OL} = 1.6mA, V_{DD} = 4.5V
All other Outputs	V_{OL}			0.6	V	I_{OL} = 8.7mA, V_{DD} = 4.5V
Output High Voltage						
OSC2	V_{OH}	V_{DD} - .7			V	I_{OH} =-1.0mA, V_{DD} = 4.5V
All other Outputs	V_{OH}	V_{DD} - .7			V	I_{OH} =-5.4mA, V_{DD} = 4.5V

These parameters are based on characterization and are not tested.

FIGURE 6-1: INPUT THRESHOLD VOLTAGE (V_{TH}) OF ALL INPUT AND I/O PINS EXCEPT $\overline{MCLR}$ AND OSC1

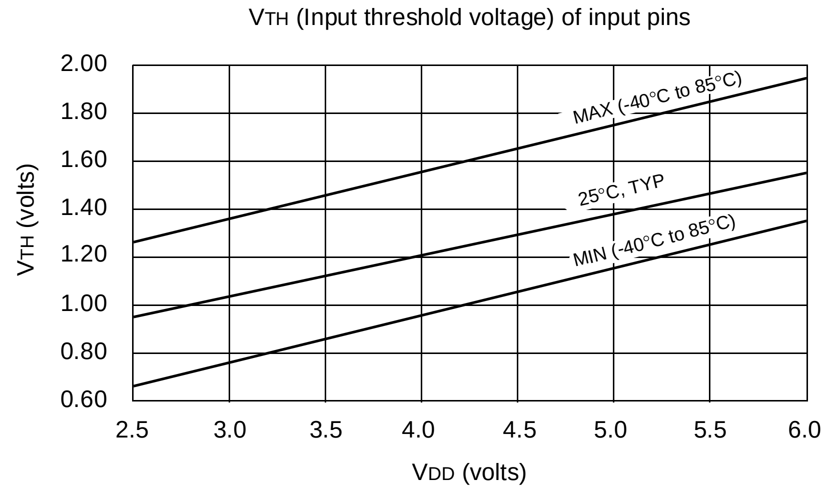
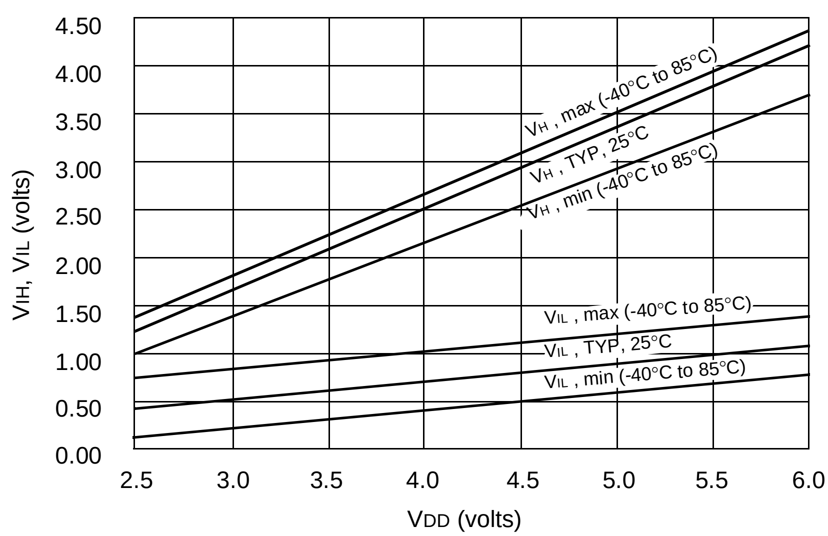


FIGURE 6-2: V_{IH}, V_{IL} OF $\overline{MCLR}$ vs V_{DD}



Note: These input pins have Schmitt trigger input buffer.

FIGURE 6-3: INPUT THRESHOLD VOLTAGE (V_{TH}) OF OSC1 INPUT

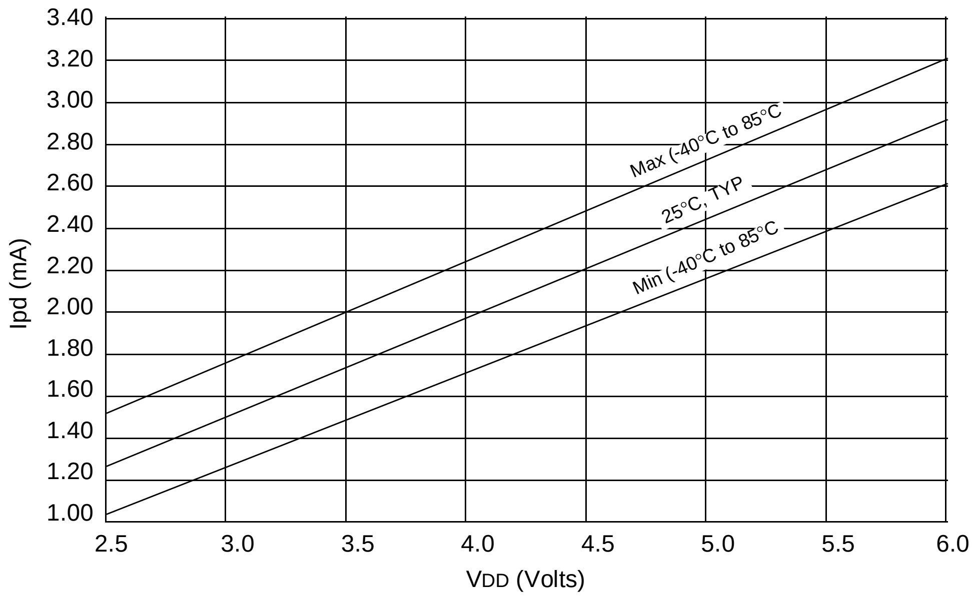


FIGURE 6-4: I_{OH} vs V_{OH}, V_{DD} = 3V

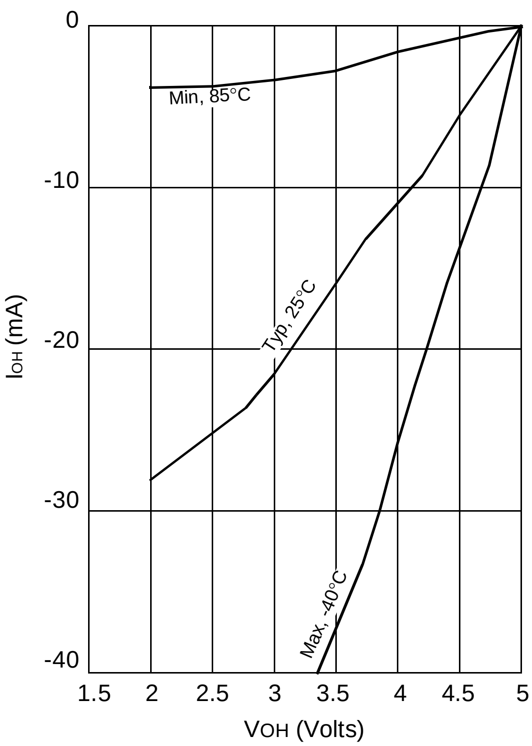


FIGURE 6-5: I_{OH} vs V_{OH}, V_{DD} = 5V

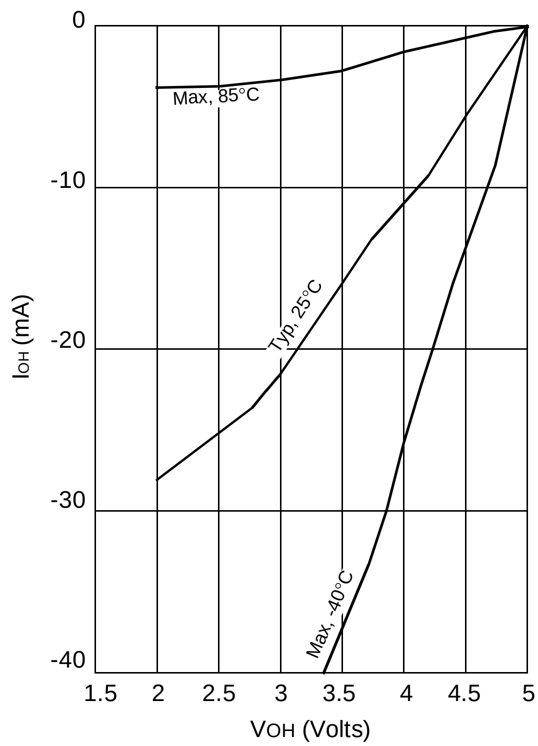


FIGURE 6-6: IOL vs VOL, VDD = 3V

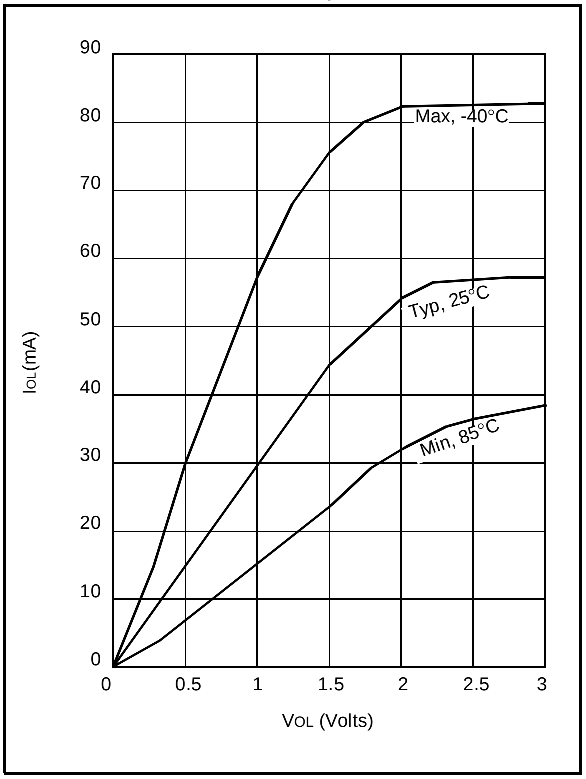
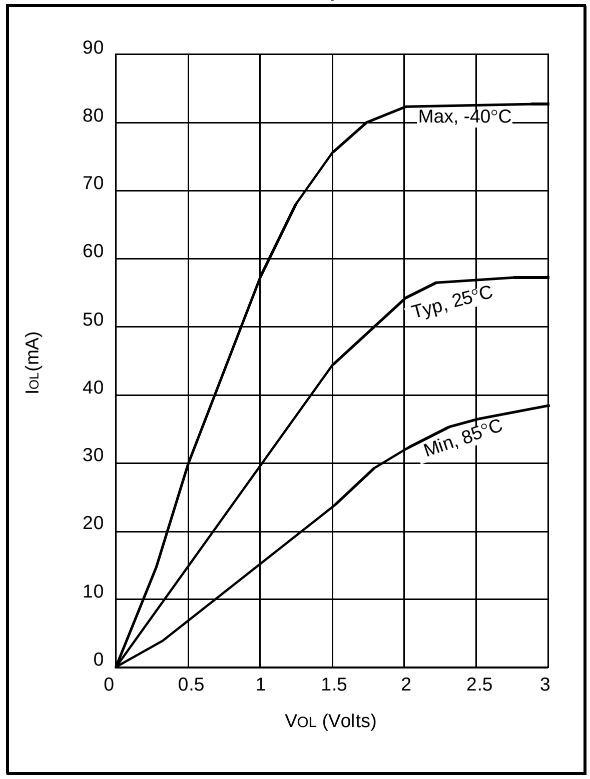


FIGURE 6-7: IOL vs VOL, VDD = 5V



6.3 AC Characteristics MTA41110 (Commercial)

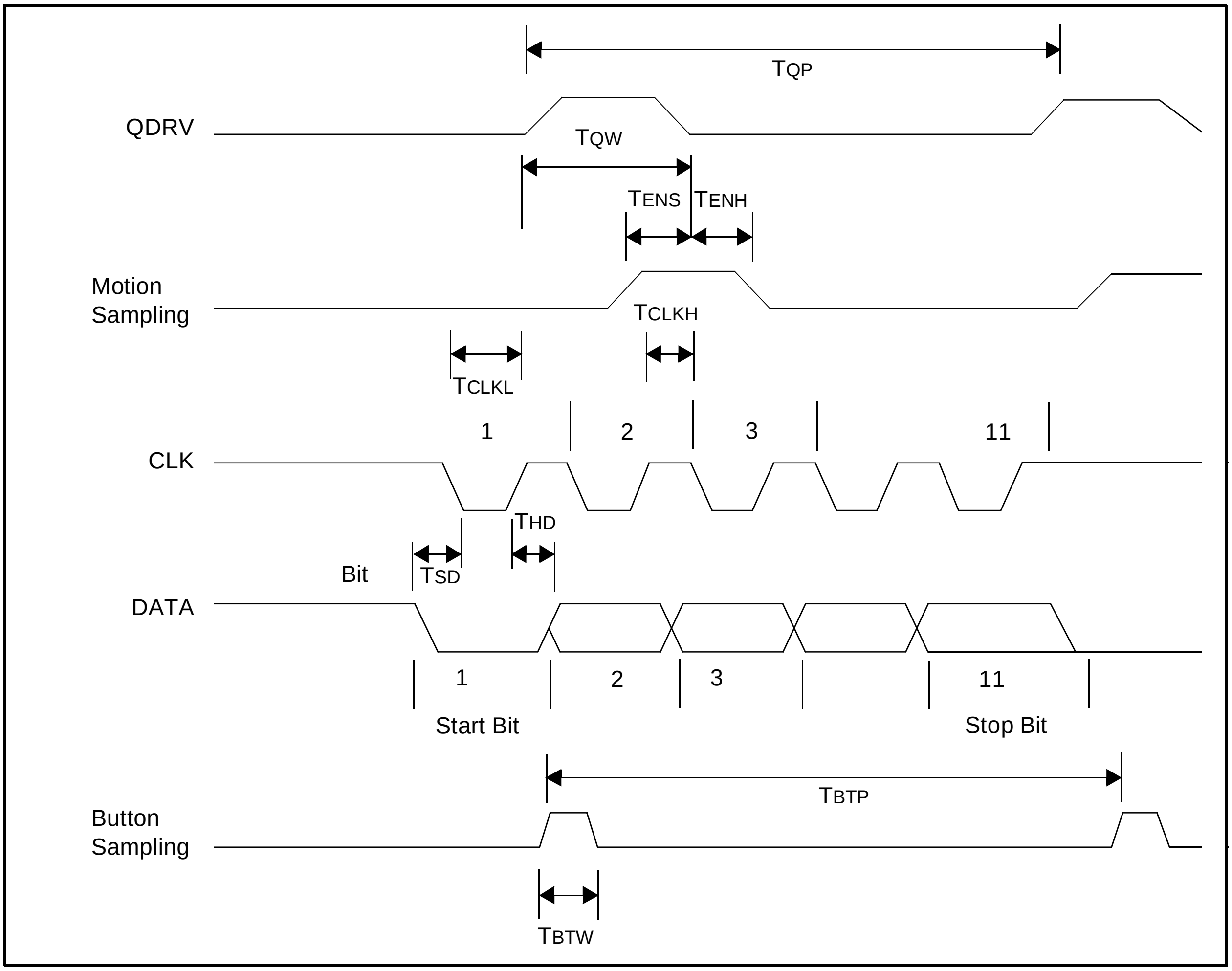
Standard Operating Conditions (unless otherwise stated).
Operating Temperature 0°C < TA < 70°C for commercial.
Operating Voltage V_{DD} = 3.0V to 5.5V unless otherwise stated.
Oscillator Frequency = 4MHz.

Characteristic	Sym.	Min.	Typ.	Max.	Units	Conditions
Oscillator Frequency	FOSC	DC		4	MHz	
Motion Encoder Timing						
QDRV						
Pulse Period	TQP (NOTE 2)		115		µS	
Pulse Width	TQW	8	10	12	µS	
HOR1,HOR2,VERT1,VERT2						
Input Sample Setup Time	TENS	3			µS	Before QDRV falling edge.
Input Sample Hold	TENH			0	nS	After QDRV falling edge.
I/O Timing						
CLK High Time	TCLKH	27		53	µS	
CLK Low Time	TCLKL	27		53	µS	
DATA setup time to CLK falling	TSD	5		25	µS	
DATA hold time to CLK rising	THD	5		45		
Button Input Timing						
$\overline{\text{PBTN}}$,$\overline{\text{SBTN}}$,$\overline{\text{DBTN}}$						
Input Sample Period	TBP (NOTE 2)			50	ms	
Input Sample Window width	TBTU			280	ns	
RESET Timing						
$\overline{\text{MCLR}}$ Pulse Width (low)	TMCL	100			ns	
Oscillator Start-up Timer Period	TOST (NOTE 1)	9	18	30	MS	VDD = 5.0V

Notes:

1. These parameters are based on characterization and are not tested.
2. Sampling period can increase if device is receiving data from host or when transmitting to host.

FIGURE 6-8: TIMING DIAGRAM



7.0 APPLICATION EXAMPLE

The MTA41110 controller can be configured as either a mouse or trackball controller. Trackball systems require the addition of the components labeled as trackball only. These components allow support of a drag lock switch and indicator. A pull-up resistor for the drag lock switch must be included in trackball systems. For a mouse, the $\overline{\text{DBTN}}$ input is simply connected to V_{DD}.

Three examples of motion encoders are shown in the schematics (Document Number 41XXXEN). Two types of optical encoders and a mechanical type are shown. Since the MTA41110 employs an anti-jitter algorithm, the "basic" style of optical encoder or the mechanical encoder are both recommended for use with the MTA41110. Use of the "improved" style of optical encoder that employs comparators may only be necessary in high noise environments.

All button switches should be of the momentary contact type, including the drag lock switch.

7.1 Host System Device Drivers

The MTA41110 is compatible with standard IBM PS/2 device drivers. Additionally, host system software device drivers for use with the MTA41110 are available from third party vendors. Contact your local sales office for a list of vendors currently offering device drivers that support the MTA41110.

FIGURE 7-1: MTA41110 BASED PS/2 MOUSE OR TRACKBALL

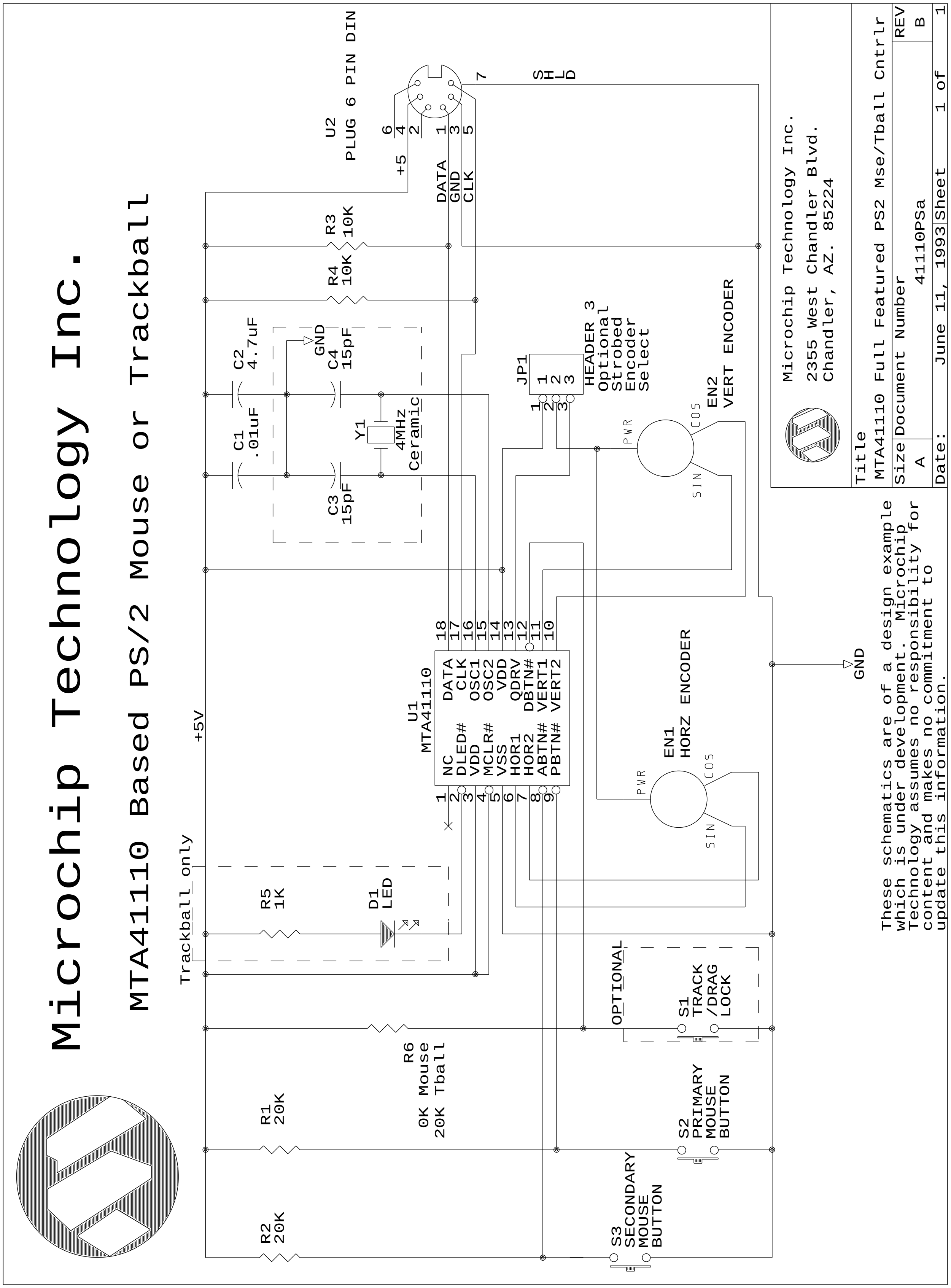


FIGURE 7-2: BASIC MOUSE/TRACKBALL OPTICAL MOTION ENCODER

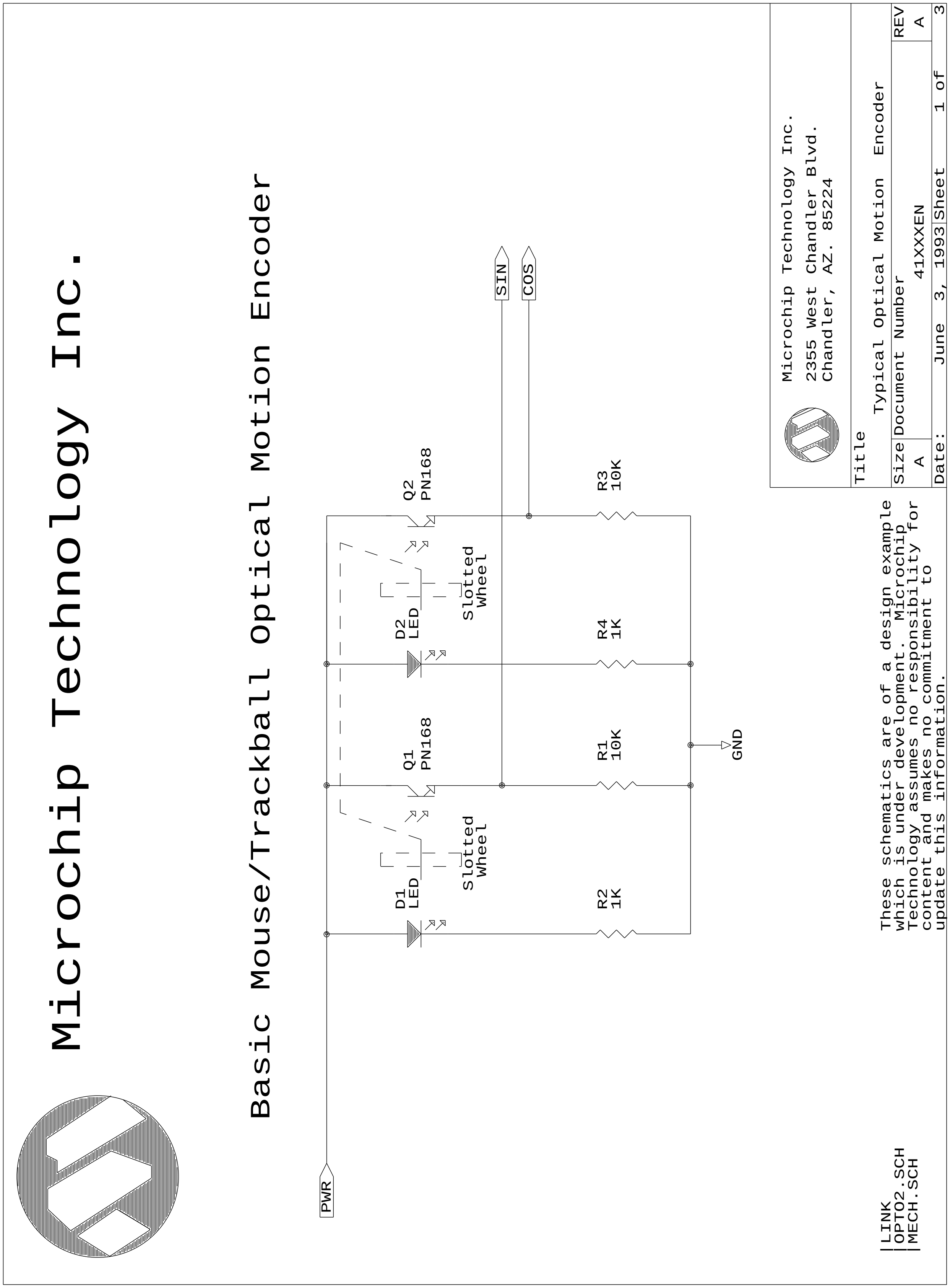


FIGURE 7-3: IMPROVED MOUSE/TRACKBALL OPTICAL MOTION ENCODER

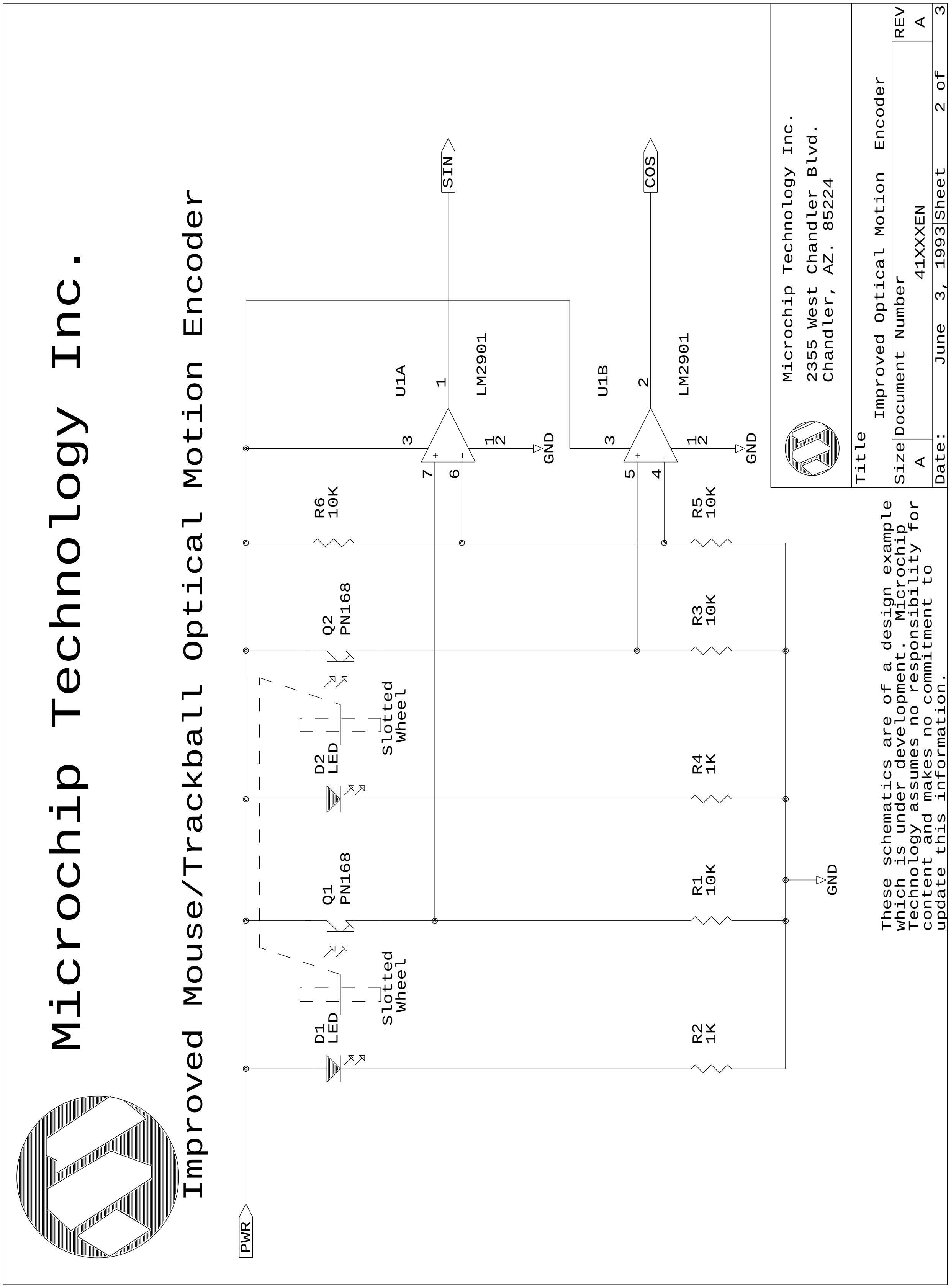
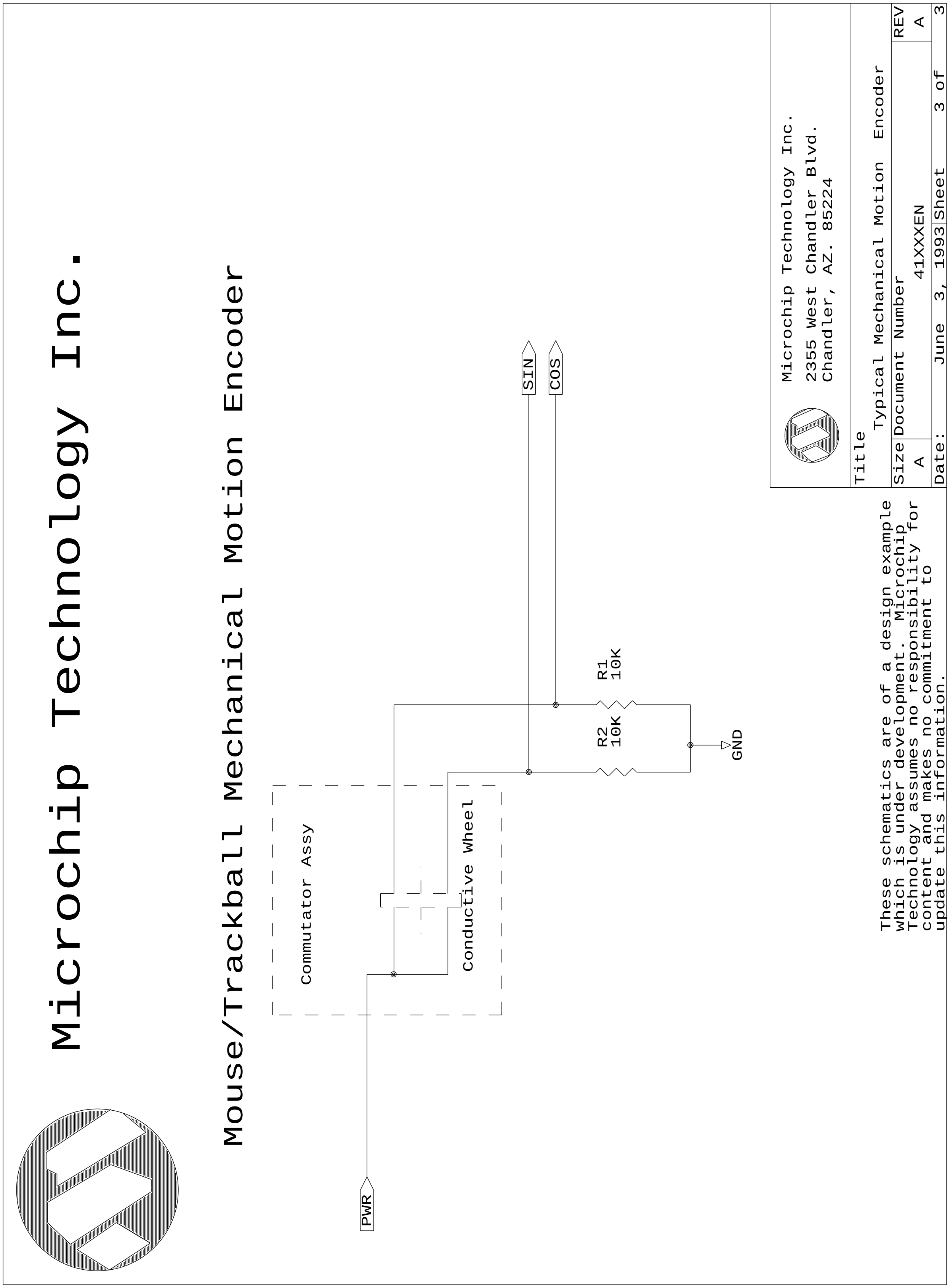
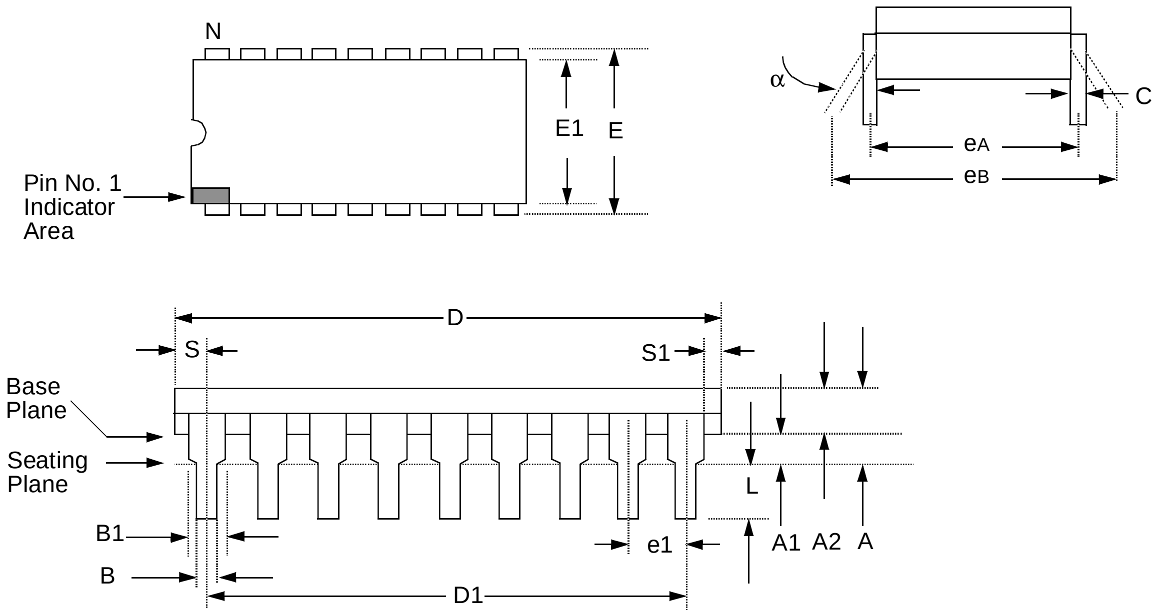


FIGURE 7-4: MOUSE/TRACKBALL MECHANICAL MOTION ENCODER



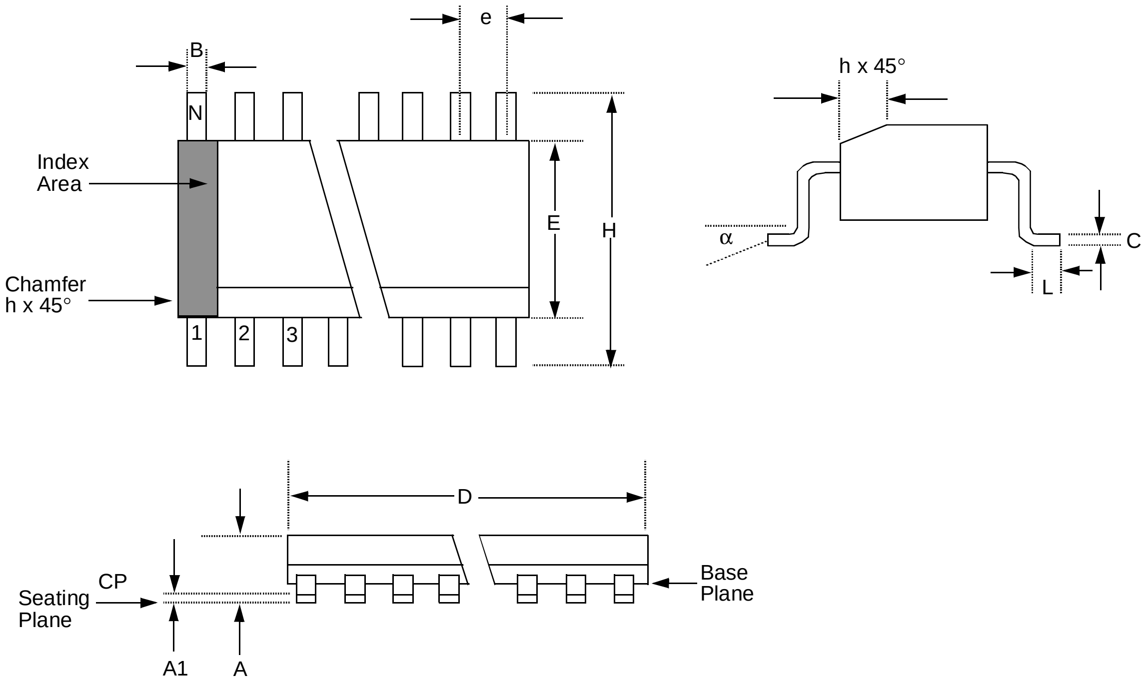
8.0 PACKAGING DIAGRAMS AND DIMENSIONS

8.1 18-Lead Plastic Dual In-Line (300mil)



	Package Group: Plastic Dual In:-Line (PLA)					
	Millimeters			**Inches**		
Symbol	**Min**	**Max**	**Notes**	**Min**	**Max**	**Notes**
α	0°	10°		0°	10°	
A	-	4.064		-	0.160	
A_1	0.381	-		0.015	-	
A_2	3.048	3.810		0.120	0.150	
B	0.3556	0.5588		0.014	0.022	
B_1	1.524	1.524	**Reference**	0.060	0.060	**Reference**
C	0.203	0.381	**Typical**	0.008	0.015	**Typical**
D	22.479	23.495		0.885	0.925	
D_1	20.320	20.320	**Reference**	0.800	0.800	**Reference**
E	7.620	8.255		0.300	0.325	
E_1	6.096	7.112		0.240	0.280	
e_1	2.4892	2.5908	**Typical**	0.098	0.102	**Typical**
e_A	7.620	7.620	**Reference**	0.300	0.300	**Reference**
e_B	7.874	9.906		0.310	0.390	
L	3.048	3.556		1.120	0.140	
N	18	18		18	18	
S	0.889	-		0.035	-	
S_1	0.127	-		0.005	-	

8.2 18-Lead Plastic Surface Mount (SOIC - Wide, 300 mil Body)

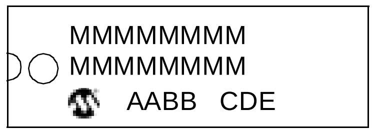


	Package Group: Plastic SOIC (SO)					
	Millimeters			Inches		
Symbol	Min	Max	Notes	Min	Max	Notes
α	0°	8°		0°	8°	
A	2.3622	2.6416		0.093	0.104	
A_1	0.1016	0.29972		0.004	0.0118	
B	0.3556	0.4826		0.014	0.019	
C	0.2413	0.3175		0.0095	0.0125	
D	11.3538	11.7348		0.447	0.462	
E	7.4168	7.5946		0.292	0.299	
e	1.270	1.270	**Reference**	0.050	0.050	**Reference**
H	10.0076	10.6426		0.394	0.419	
h	0.381	0.762		0.015	0.030	
L	0.4064	1.143		0.016	0.045	
N	18	18		18	18	
CP	-	0.1016		-	0.004	

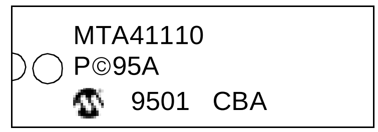
9.0 PACKAGE MARKING INFORMATION

.

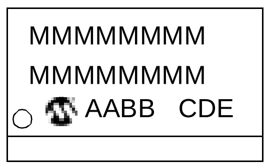
18L PDIP (0.300 mil)



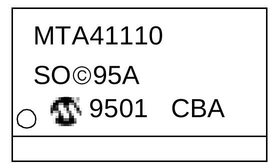
Example



18L SOIC



Example



Legend:	MM...M	Microchip part number information
	AA	Year code (last 2 digits of calendar year)
	BB	Week code (week of January 1 is week '01')
	C	Facility code of the plant at which wafer is manufactured. C = Chandler, Arizona, U.S.A.
	D	Mask revision number
	E	Assembly code of the plant or country of origin in which
Note:	In the event the full Microchip part number can not be marked on one line, it will be carried over to the next line.	

NOTES:

MTA41110 Product Identification System

To order or to obtain information (e.g., on pricing or delivery), please use the listed part numbers, and refer to the factory or the listed sales offices.

PART NO. -X /XX X

- **Revision:**
- **Package:** P = 300 mil PDIP; SO = 300 mil SOIC (Gull Wing Lead)
- **Temperature Range:** - = 0°C to +70°C
- **Device:** MTA41110

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