A/D Converter

MB4052

4-Channel / 8-Bit

DATASHEET

OEM – Fujitsu

Source: Fujitsu Databook 1983

Datasheet Rev. 1.3 – 04/19 – data without warranty / liability

FUJITSU MICROELECTRONICS

MB4052

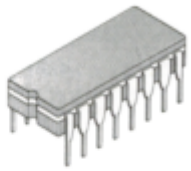
4-CHANNEL 8-BIT A/D CONVERTER

DESCRIPTION

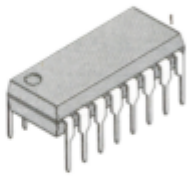
The Fujitsu MB4052 is an analog-to-digital converter (ADC) for general purpose which features four channels of analog inputs and 8-bit data length of digital output.

Analog input signal is converted to serial 8-bit digital data by the successive-approximation technique which provides high-speed conversion, i.e. many analog data can be converted within a short time.

All digital I/O signals including control inputs are TTL level compatible so as to provide wide application such as in microprocessor-controlled system and so on. The MB4052 is packaged in a standard 16-pin dual in-line package.



CERAMIC PACKAGE
DIP-16C-C02

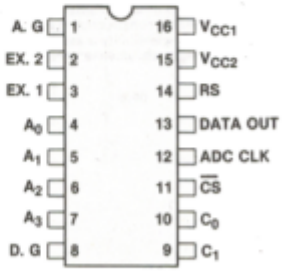


PLASTIC PACKAGE
DIP-16P-M02

FEATURES

- **Single Power Supply**
  +3.5V to +6.0V or +8.0V to +18V (with Internal Regulator)
- **Multiplex 4-Channel Analog Inputs**
- **Analog Input Voltage Ranges**
  0 to 1/2V_{CC1} (Standard mode: RS = 1)
  0 to 1/8V_{CC1} (Contracted mode: RS = 0)
  0 to 2V_{CC1} (Expanded mode: through built-in Divider)
- **Analog Input Bias Current 250nA Max.**
- **Resolution — 8 bits**
- **Linearity — 0.19% Max.**
- **Successive-Approximation Conversion**
  100μs/ch Max. at f_{CLK} = 100 kHZ
- **Radio-metric Conversion by Reference Voltage V_{CC1}**
- **Serial Data Output (Open Collector)**
- **TTL/CMOS Compatible Digital I/O**
- **Power Consumption**
  75mV Typ. at V_{CC1} = 5V
- **Standard 16-pin Dual In-line Package**
  Plastic Package — General Use
  Ceramic Package — Precision Use

PIN ASSIGNMENT



ABSOLUTE MAXIMUM RATINGS*

(All Voltages referenced to A.G/D.G)

Rating		Symbol	Value	Unit
Power Supply Voltage		V_{CC1}	+7	V
		V_{CC2}	+20	V
Digital Input Voltage		V_{ID}	-0.5 to +20	V
Digital Output Voltage (Off-State)		V_{OH}	+20	V
Analog Input Voltage		V_{IA}	V_{CC1} +0.5	V
Operating Temperature		T_A	-35 to +90	°C
Storage Temperature	Ceramic	T_{STG}	-55 to +150	°C
	Plastic		-40 to +125	

*Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ANALOG CIRCUIT CHARACTERISTICS FOR PLASTIC PACKAGE

(Recommended Operating Conditions unless otherwise noted.)

Parameter		Symbol	Value			Unit
			Min.	Typ.	Max.	
Resolution			–	–	8	Bit
Linearity Error (V_{CC1} = 5.000V)			–	–	±0.5	LSB
Differential Linearity Error (V_{CC1} = 5.000V)			–	–	±0.9	LSB
Zero Transition Voltage (V_{CC1} = 5.000V, T_A = 25°C)	Contracted Range	V_{ZC}	0	6	16	mV
	Starndard Range	V_{ZS}	7	17	27	mV
	Expanded Range	V_{ZE}	22	62	102	mV
Full Scale Transition Voltage (V_{CC1} = 5.000V, T_A = 25°C)	Contracted range	V_{FC}	600	625	650	mV
	Standard Range	V_{FS}	2.475	2.500	2.525	V
	Expanded Range	V_{FE}	9.600	10.000	10.400	V
Comparator Input Current (V_{CC1} = 5.000V)		I_{IC}	–	-100	-250	nA
Divider Input Resistance for Expanded Range		R_{INE}	5	10	15	kΩ
Regulator Output Voltage (V_{CC2} = 8.0V to 18.0V)		V_{OR}	4.5	5.0	5.5	V
Regulator Line Regulation (V_{CC2} = 8.0V to 18.0V)			–	4.0	–	mV/V
Regulator Load Regulation (V_{CC2} = 12V, 0mA ≦ I_{OUT} ≦ -10mA)			–	0.5	–	mV/mA
Regulator Output Temperature Coefficient (V_{CC2} = 12V)			–	50	–	ppm/°C
Conversion Cycle Time (f_{CLK} = 100kHz)		t_{CYC}	–	–	100	μs/ch

A minus sign (–) prefixed to a current value indicates that the current flows from the IC to the external circuit.

MB4052

ANALOG CIRCUIT CHARACTERISTICS FOR CERAMIC PACKAGE

(Recommended Operating Conditions unless otherwise noted.)

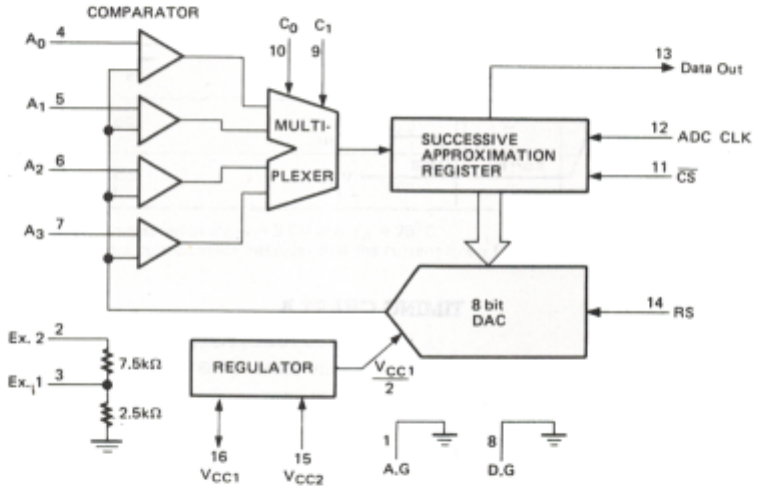
Parameter		Symbol	Value			Unit
			Min.	Typ.	Max.	
Resolution			–	–	8	Bit
Linearity Error (V_{CC1} = 5.000V)			–	–	±0.4	LSB
Differential Linearity Error (V_{CC1} = 5.000V)			–	–	±0.8	LSB
Zero Transition Voltage (V_{CC1} = 5.000V, T_A = 25°C)	Contracted Range	V_{ZC}	0	6	16	mV
	Standard Range	V_{ZS}	7	17	27	mV
	Expanded Range	V_{ZE}	22	62	102	mV
Full Scale Transition Voltage (V_{CC1} = 5.000V, T_A = 25°C)	Contracted Range	V_{FC}	610	625	640	mV
	Standard Range	V_{FS}	2.480	2.500	2.520	V
	Expanded Range	V_{FE}	9.760	10.000	10.240	V
Comparator Input Current		I_{IC}	–	-100	-250	ınA
Divider Input Resistance for Expand Range		R_{INE}	5	10	15	kΩ
Regulator Output Voltage (V_{CC2} = 8.0V to 18.0V)		V_{OR}	4.75	5.0	5.5	V
Regulator Line Regulation (V_{CC2} = 8.0V to 18.0V)			–	4.0	–	mV/V
Regulator Load Regulation (V_{CC2} = 12V, 0mA ≦ I_{OUT} ≦ -10mA)			–	0.5	–	mV/mA
Regulator Output Temperature Coefficient (V_{CC2} = 12V)			–	50	–	ppm/°C
Conversion Cycle Time (f_{CLK} = 100kHz)		t_{CYC}	–	–	100	µs/ch

A minus sign (–) prefixed to a current value indicates that the current flows from the IC to the external circuit.

RECOMMENDED OPERATING CONDITIONS (T_A = −30 °C to +85 °C)

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Power Supply Voltage	V_{CC1}	3.5	5.0	6.0	V
	V_{CC2}	8.0	12.0	18.0	V
Digital Input High Voltage	V_{IH}	2.0	–	–	V
Digital Input Low Voltage	V_{IL}	–	–	0.8	V
Digital Output Low Current	I_{OL}	–	–	8	mA

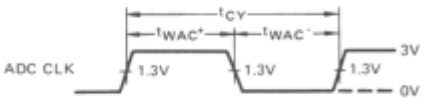
MB4052 BLOCK DIAGRAM



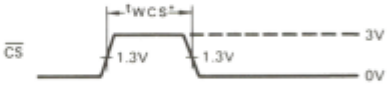
MB4052

TIMING CHART A

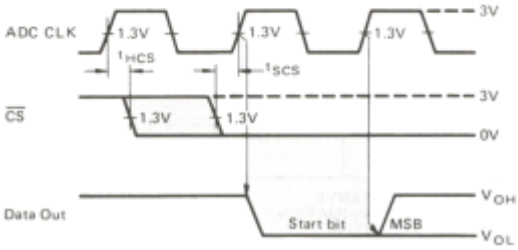
(1) ADC CLK



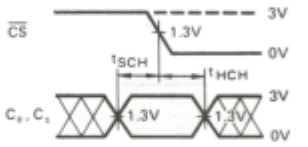
(2) $\overline{CS}$



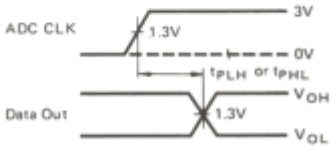
(3) $\overline{CS}$ Set-up/Hold Time



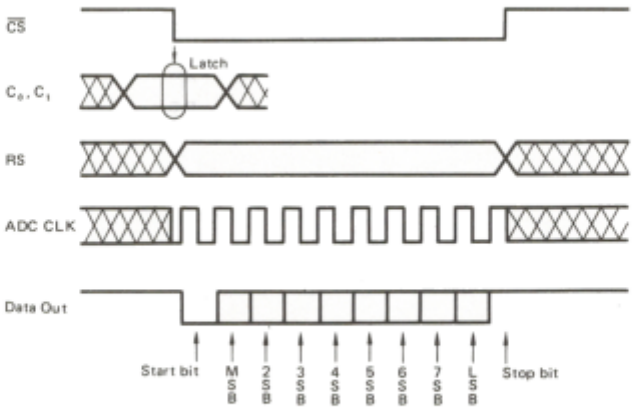
(4) Channel Set-up/Hold Time



(5) Propagation Delay Time



TIMING CHART B



Note: RS should be held to one ranged "1" or "0" until data conversion is completed.

DIGITAL CIRCUIT DC CHARACTERSISTICS

(V_{CC1} = V_{CC2} = 3.5V to 6.0V, T_A = −30 °C to +85 °C unless otherwise noted.)

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Input Clamp Voltage (V_{CC1} = 3.5V, I_{IL} = −18mA)	V_{IC}	–	–	-1.5	V
Output High Current (V_{CC1} = 3.5V, V_{IH} = 2.0V, V_{IL} = 0.8V, V_{OH} = 20V)	I_{OH}	–	–	100	μA
Output Low Voltage (V_{CC1} = 3.5V, V_{IH} = 2.0V, V_{IL} = 0.8V, I_{OL} = 4mA)	V_{OL1}	–	–	0.4	V
Output Low Voltage (V_{CC1} = 3.5V, V_{IH} = 2.0V, V_{IL} = 0.8V, I_{OL} = 8mA)	V_{OL2}	–	–	0.5	V
Input High Current (V_{CC1} = 6.0V, V_{IH} = 2.7V)	I_{IH1}	–	–	20	μA
Input High Current (V_{CC1} = 6.0V, V_{IH} = 20V)	I_{IH2}	–	–	100	μA
Input Low Current (V_{CC1} = 6.0V, V_{IL} = 0.4V)	I_{IL}	–	-50	-150	μA
Power Supply Current for V_{CC1} (V_{CC1} = 6.0V)	I_{CC1}	–	15*	30	mA
Power Supply Current for V_{CC2} (V_{CC2} = 20V, V_{CC1} = Open)	I_{CC2}	–	15	25	mA

***Note:** This typical value is measured at V_{CC1} = 5.0V and T_A = 25°C.
A minus sign (–) prefixed to a current value indicates that the current flows from the IC to the external circuit.

DIGITAL CIRCUIT AC CHARACTERISTICS

(V_{CC1} = 3.5V to 6.0V, T_A = −30 °C to +85 °C unless otherwise noted.)

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
ADC CLK Cycle Time	t_{CY}	10	–	–	μs
ADC CLK H level Pulse Width	$t_{WAC}{}^{+}$	2.5	–	–	μs
ADC CLK L level Pulse Width	$t_{WAC}{}^{-}$	2.5	–	–	μs
$\overline{CS}$ H level Pulse Width	$t_{WCS}{}^{+}$	1.5	–	–	μs
$\overline{CS}$ Set-up Time	t_{SCS}	1	–	–	μs
$\overline{CS}$ Hold Time	t_{HCS}	1	–	–	μs
Channel Set-up Time	t_{SCH}	0	–	–	μs
Channel Hold Time	t_{HCH}	1	–	–	μs
Propagation Delay Time	t_{PLH} t_{PHL}	–	800	2,000	ns

See TIMING CHART A

PIN DESCRIPTIONS

INPUT FOR VOLTAGE RANGE EXPANSION (EX 2), PIN 2

This input pin is provided to expand the voltage range of analog input signal.
This input pin is connected to the internal one-to-four voltage divider which reduces an analog signal level to one fourth of input level.

OUTPUT FOR VOLTAGE RANGE EXPANSION (EX 1), PIN 3

This output pin is provided to expand the allowable analog input level in co-operation with the above EX 2 pin.
A reduced signal which is divided in the internal divider is output on this pin.
This output pin can be connected to any of standard analog inputs A_0, A_1, A_2 or A_3 so that the EX 2 pin can function as one of 4-channel inputs.

ANALOG INPUTS (A_0 TO A_3), PINS 4, 5, 6 AND 7

These input pins are provided to receive four channels of analog inputs.
One of these four channels is selected by a combination of C_0 and C_1 inputs.

CHANNEL SELECT (C_1 AND C_0), PINS 9 AND 10

These control inputs are used to designate one of four analog inputs as shown in Table 1.

Table 1 CHANNEL SELECTION

C_1	C_0	Channel
0	0	A_0
0	1	A_1
1	0	A_2
1	1	A_3

CHIP SELECT ($\overline{CS}$), PIN 11

This control input pin is used to start analog-to-digital conversion.
When $\overline{CS}$ goes low, the A/D conversion start and the DATA OUT output is enabled.
When an A/D conversion is completed or termination of conversion is required, $\overline{CS}$ is made high.

A/D CONVERSION CLOCK (ADC CLK), PIN 12

This clock signal is input to the internal successive approximation register and used as timing signal for A/D conversion.
The conversion speed of this device is determined by this clock rate.
Ten clock cycles are required for a complete 8-bit conversion.
A precise cycle time is not always required for this clock signal.

DATA OUTPUT (DATA OUT), PIN 13

This output pin is provided to output the A/D conversion results as digital signals.
The converted digital data are serially output in the order of start-bit, MSB (Most Significant Bit), 2SB (Second Significant Bit), . . . , 7SB, LSB (Least Significant Bit) and stop-bit in synchronization with the ADC CLK clock signal.

RANGE SELECT (RS), PIN 14

This control input is provided to select an analog input voltage range as shown in Table 2.
This input must not be changed during an A/D conversion.

Table 2 RANGE SELECTION

RS	Voltage Range
0	0 to 1/8 V_{CC1}
1	0 to 1/2 V_{CC1}

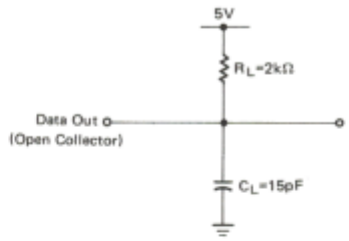
ANALOG GROUND (A.G) AND DIGITAL GROUND (D.G), PINS 1 AND 8

These are terminals for ground.
The analog circuitry and digital circuitry have seperate ground terminals, respectively.

POWER SUPPLIES (V_{CC2} AND V_{CC1}), PINS 15 AND 16

When the device operates within a voltage range of 3.5V to 6.0V, the power source is connected to V_{CC1} which is shorted to V_{CC2}.
When the device operates within a voltage range of 8V to 18V, the power source is connected to V_{CC2}.
In this high voltage operation mode, the V_{CC1} pin is used as an output pin which supplies +5V stabilized voltage and 10mA load current and the supplied voltage is regulated in the internal voltage regulator.
V_{CC1} is used as the reference voltage of A/D conversion.

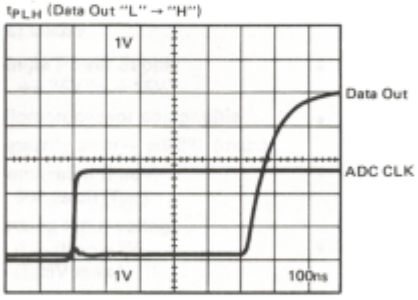
LOAD CONDITIONS



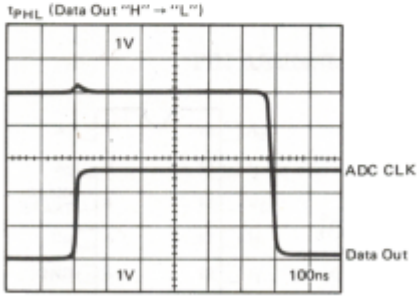
OPERATION EXAMPLE

1. Propagation Delay

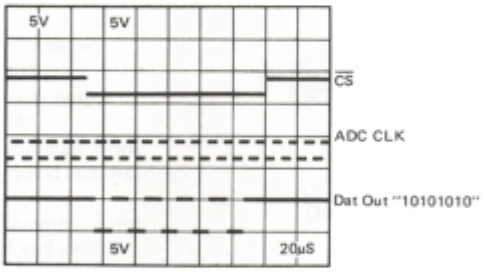
t_{PLH} (Data Out "L" → "H")



t_{PHL} (Data Out "H" → "L")



2. Convension



Condition
f_{CLK} = 100kHz
V_{CC1} = 5V
Standard Range
V_{IA} ≒ 1663 mV

MB4052

EXAMPLE OF EXPAND RANGE MODE CONNECTION