Real Time System

Third Level

Lecture Ten

8155/8156 Multipurpose Programmable Devices

Dr. Hussein AbdulAlmeer Alkhamees

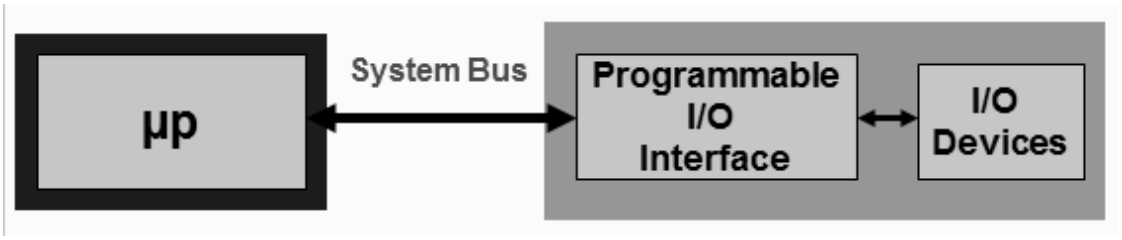
Hussein.Alkhamees@uomus.edu.iq

Goals
Up-on completing this lecture, the student should be able to:

1- Identify the concepts behind programmable devices
2- Utilize the programmable devices into the RT designs.

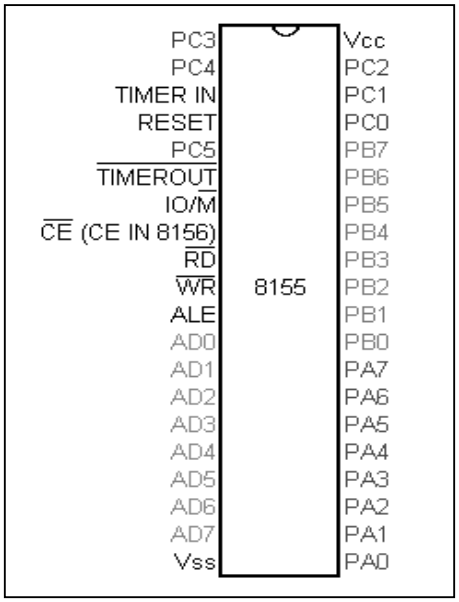
Programmable Interface Devices

- Used to interface an I/O device to the microprocessor.
- Can be programmed/configured to perform various I/O functions by writing software instructions.



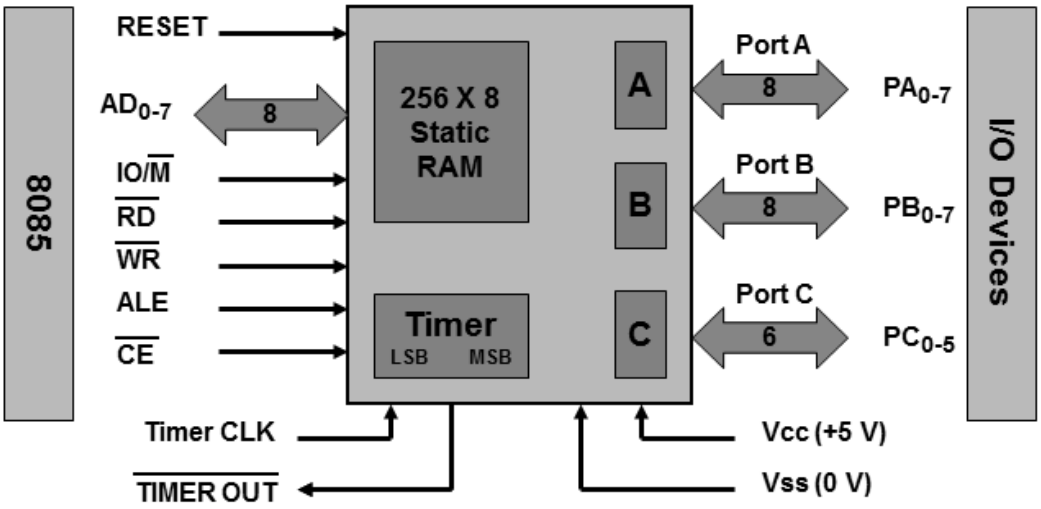
8155/8156 – A Multipurpose Programmable Interface

Its programmable interface device used to interface I/O device to µP, its multifunction device, contain RAM, I/O ports, and timer.



- Designed to be compatible with 8085.
- It includes:
  - 256 bytes of Read/Write memory.
  - Three I/O ports (programmable I/O):
    - Port A (8-bit).
    - Port B (8-bit).
    - Port C (6-bit).
  - A 14-bit timer.

BLOCK DIAGRAM - 8155

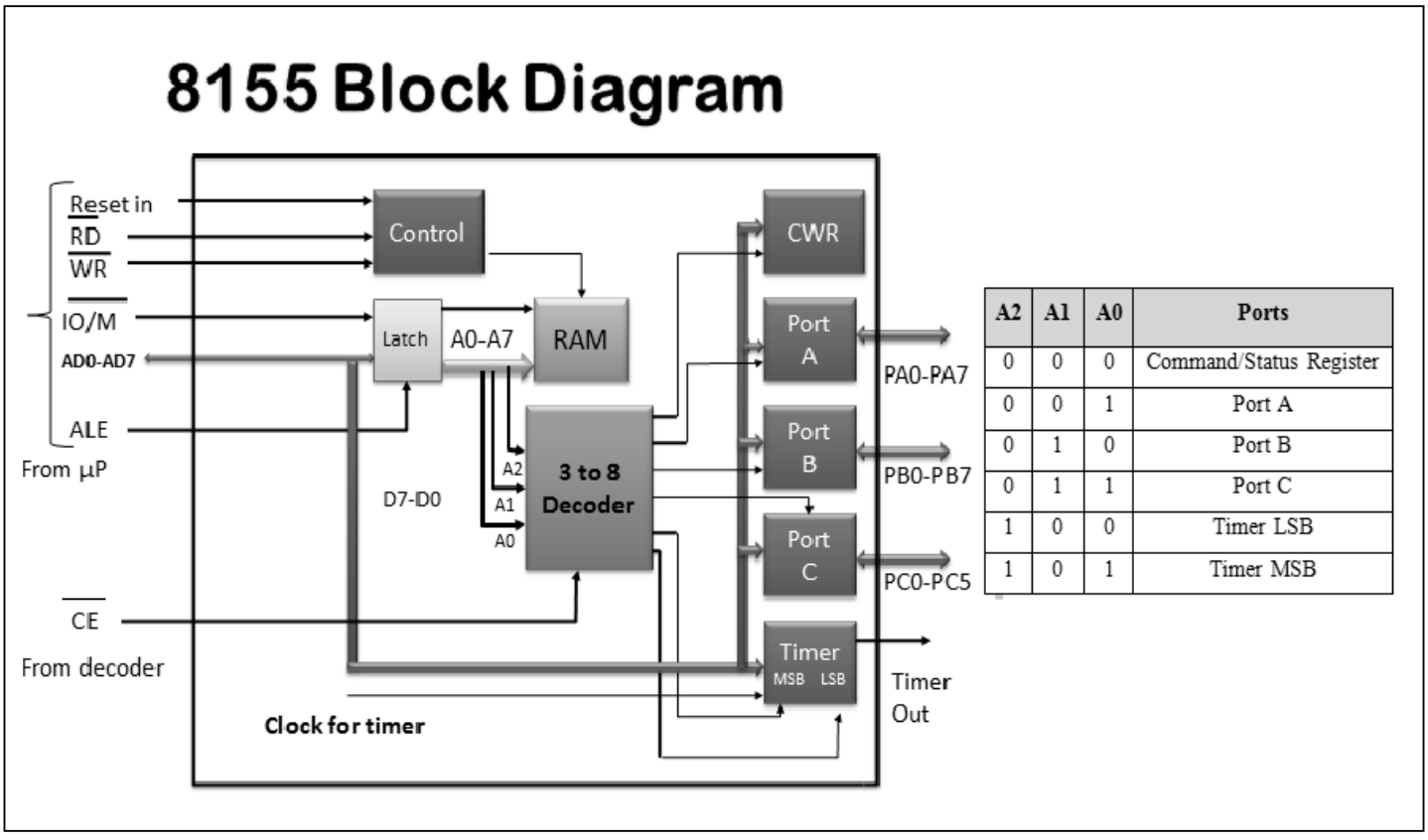


The 8155/8156 is a device with two sections:

- The first is 256 byte static memory (RAM).
- The second is programmable I/O ports.

Functionally the two sections is used as two independence chips, the I/O section include two 8 bit parallel I/O ports (A, B), and one 6 bit port (C), and bit timer, all ports can be simply configured as I/O ports.

- 8155 block diagram shows 5 control signals, all except ($\overline{CE}$) are input signal directly generated by the processor; the ($\overline{CE}$) is input from decoder.
  - $\overline{CE}$: chip enable, connected to the decoder.
  - IO/$\overline{M}$: specify whether the memory section is selected, or I/O section (include timer) is selected.
  - ALE: address latch enable.
  - $\overline{RD}$ and $\overline{WR}$
  - RESET: connect to the RESET out of processor used to reset the chip and initializes I/O ports as input.
- In 8155 we have control register, 3 I/O ports, and 2 register for timer, so we need 3 address lines to decode there register.

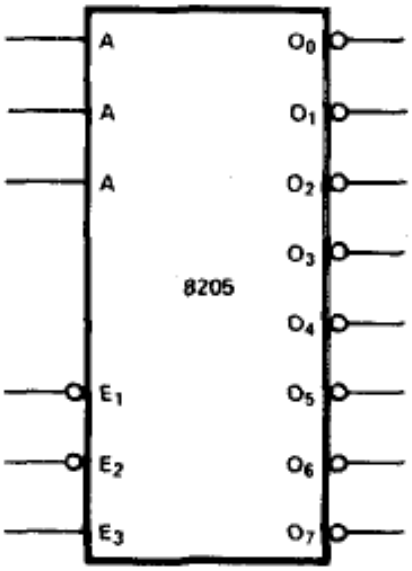


A2	A1	A0	Ports
0	0	0	Command/Status Register
0	0	1	Port A
0	1	0	Port B
0	1	1	Port C
1	0	0	Timer LSB
1	0	1	Timer MSB

How to Calculate Address of control register and I/O Ports of 8155?

By using 3 to 8 decoder 8205 which have 3 enables.

Why and How?

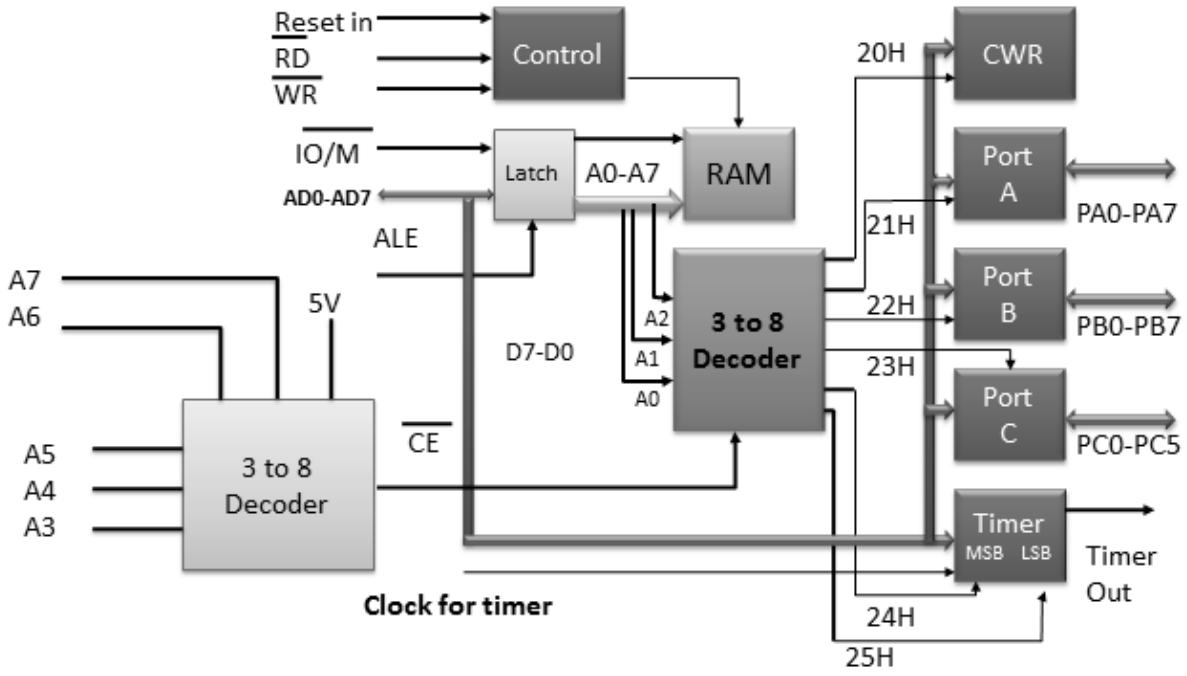


ADDRESS			ENABLE			OUTPUTS							
A	A	A	E_1	E_2	E_3	0	1	2	3	4	5	6	7
L	L	L	L	L	H	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
L	H	L	L	L	H	H	H	L	H	H	H	H	H
H	H	L	L	L	H	H	H	H	L	H	H	H	H
L	L	H	L	L	H	H	H	H	H	L	H	H	H
H	L	H	L	L	H	H	H	H	H	H	L	H	H
L	H	H	L	L	H	H	H	H	H	H	H	L	H
H	H	H	L	L	H	H	H	H	H	H	H	H	L
X	X	X	L	L	L	H	H	H	H	H	H	H	H
X	X	X	H	L	L	H	H	H	H	H	H	H	H
X	X	X	L	H	L	H	H	H	H	H	H	H	H
X	X	X	H	H	L	H	H	H	H	H	H	H	H
X	X	X	H	L	H	H	H	H	H	H	H	H	H
X	X	X	L	H	H	H	H	H	H	H	H	H	H
X	X	X	H	H	H	H	H	H	H	H	H	H	H

Figure 1. Logic Symbol

An 8205 it's a binary decoder (high speed 1 out of 8 binary decoder), it have 3 enable (E1, E2, E3), to enable this decoder, the E1, 2 must be low and E3 must be high. The active output pin of this decoder is low.

Ex: determine the address of the control/status, I/O ports and timer register in the following fig.?



Ex: design (draw) and determine the address of the control/status, I/O ports and timer register of the 8155 if the output of decoder O2?

Application design with 8155:

- Interfacing 8155 with 8085.
- Programming 8155.

Ex: design a full system contains microprocessor and 8155 and I/O device with its connections and shows how can any output of the decoder active the interfacing proses by using 8205?

What type of Commands can be given to 8155?

- To configure the I/O ports as Input or Output.
- To start/stop timer.
- To use handshake mode or not.

Programming 8155:

- 8155 is a Programmable Peripheral Interface.
- 8085 can send data to 8155 using data bus.
- This data can be:-
  - For I/O devices connected to 8155.

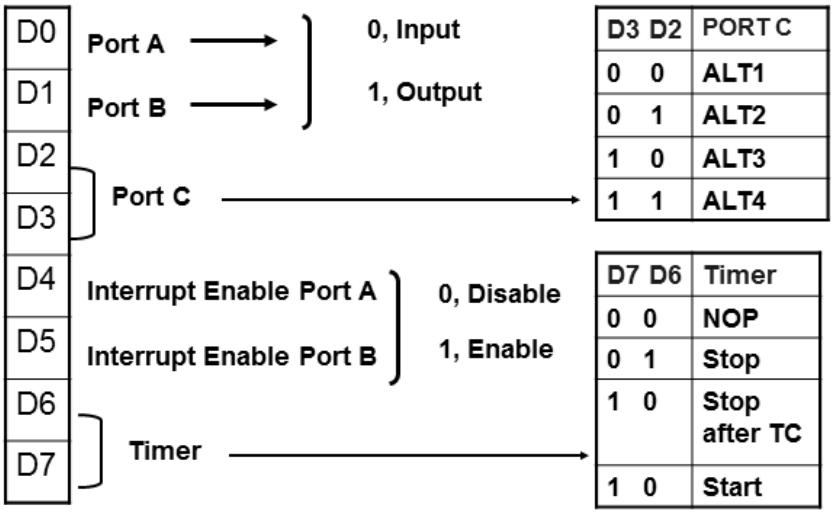
- Timer registers of 8155.
- Instruction/Command word for 8155.

- Commands for 8155 are stored in an 8-bit Control Register inside 8155.

Control word for 8155:-

- A command/instruction for 8155 is also called control word.
- This control word is written to control register of 8155.
- Control word of 8155 is of 8-bits.

Control word (command reg) format



D3 D2	PORT C
0 0	ALT1
0 1	ALT2
1 0	ALT3
1 1	ALT4

D7 D6	Timer
0 0	NOP
0 1	Stop
1 0	Stop after TC
1 0	Start

- 00: No effect
- 01: Stop if running else no effect
- 10: Stop after terminal count (TC) if running, else no effect
- 11: Start if not running.

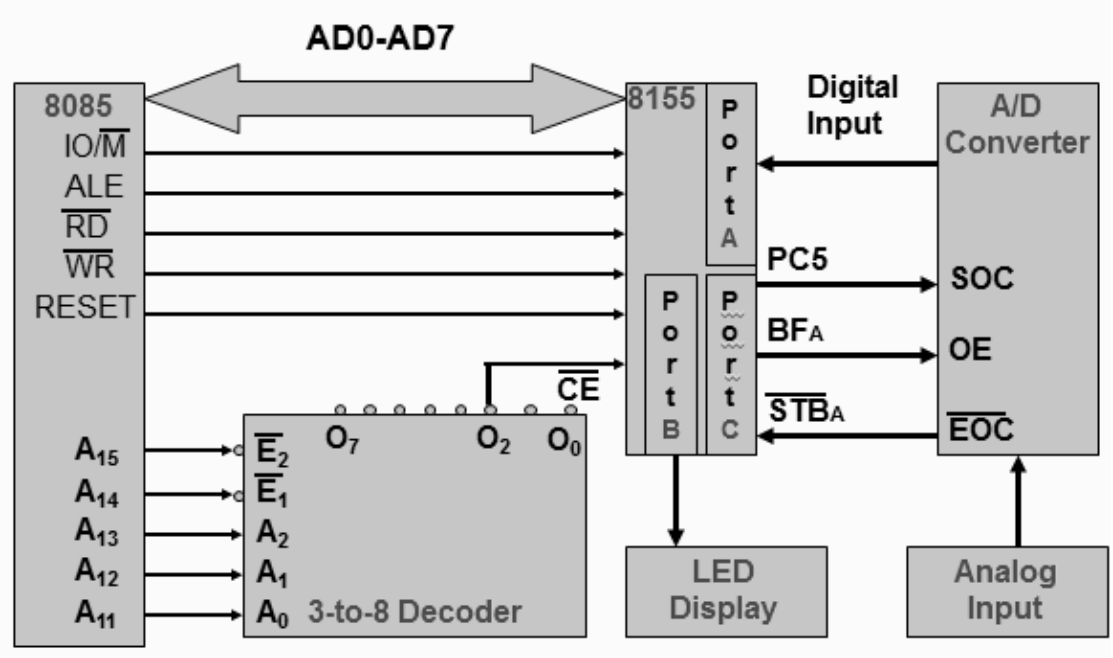
I/O functions of Port C

ALT	D3 D2	PC5	PC4	PC3	PC2	PC1	PC0
ALT1	0 0	I	I	I	I	I	I
ALT2	0 1	O	O	O	O	O	O
ALT3	1 0	O	O	O	$\overline{STB}_A$	BF_A	$INTR_A$
ALT4	1 1	$\overline{STB}_B$	BF_B	$INTR_B$	$\overline{STB}_A$	BF_A	$INTR_A$

I = Input O = Output

STB = Strobe BF = Buffer Full INTR = Interrupt Request

Ex: Design an interfacing circuit to read data from an A/D converter using the 8155A in the peripheral mapped I/O.



Chip Selection

A7 A6 A5 A4 A3

0 0 0 1 0

A2	A1	A0	Port	
0	0	0	Control/Status Register	= 10H
0	0	1	Port A	= 11H
0	1	0	Port B	= 12H
0	1	1	Port C	= 13H
1	0	0	LSB Timer	= 14H
1	0	1	MSB Timer	= 15H

8155: Timers

The 8155 timer consists of two 8-bit registers, 8-bit LSB and 8-bit MSB. In these 16 bits, 14 bits are used for counter and two bit for mode selection. The counter is a 14 bit down counter. It can operate in 4 different modes of operation. We can select mode using two bits M2 and M1:

- 00(Mode 0) Single Square Wave.

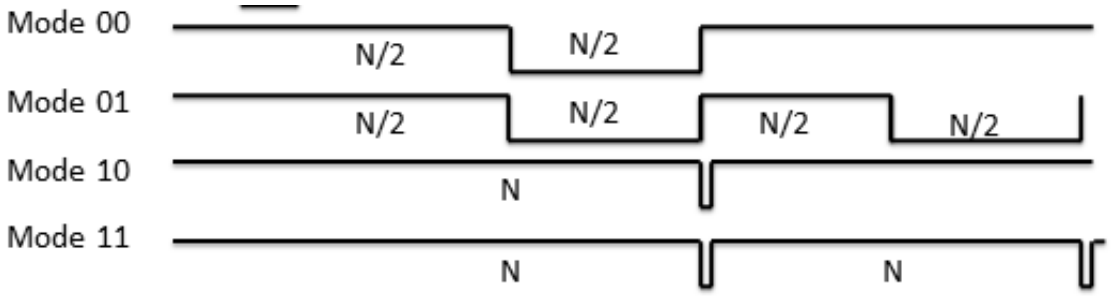
- 01(Mode 1) Square Wave.
- 10(Mode 2) Single Pulse on TC (terminal count).
- 11(Mode 3) Pulse every TC.

Mode 0: In this mode, timer gives only one cycle of square wave, the output remains high for 1/2 count and remains low for 1/2 count (N is the count value).

Mode 1: This mode is similar to single square wave in operation but the when counter becomes zero, the count value is automatically reloaded. Thus it provides continuous square wave.

Mode 2: This mode gives a single clock pulse as an output of the end of the count the output is high normally, but it becomes low for 1 clock pulse and again it will become high and remain high.

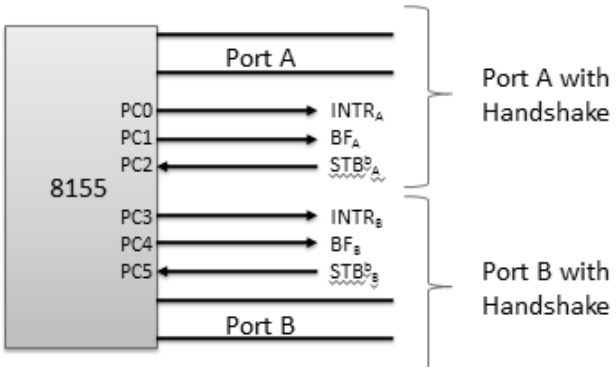
Mode 3: This mode is similar to mode 2 but when the counter becomes zero the count value is automatically reloaded. Thus it provides continuous pulses.



The 8155 I/O ports in handshake mode:

Two I/O port of 8155 (A, B) can be configured in the handshake mode, each uses there signals from port C as a control signal.

When port A configured in the handshake mode, it will uses the lower 3 signals of port C, PC0, PC1, PC2. When port B configured in the handshake mode, it will uses the upper 3 signals of port C, PC3, PC4, PC5.



The function of these signals as follows:

- $\overline{\text{STB}}$ (strobe): this is input handshake signal from peripheral to 8155.
- BF (buffer full): this is indicating the presence of the data byte in the port.
- INTR (interrupt request): this signal used to interrupt the MPU.
- INTE (interrupt enable): used to disable or enable the interrupt capability of the 8155.

Status word:

- MPU check the status Reg of port or timer.
- Control register & Status register have same port.
- Differentiated by $\overline{\text{RD}}$ and $\overline{\text{WR}}$ signals.

Status word (Status reg) format:

D7	D6	D5	D4	D3	D2	D1	D0
X	Timer	INTEb	BFb	INTRb	INTAa	BFa	INTRa

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Summary:
1- Prog devices hugely reduce the load on CPUs.
2- The 8155 is the foundation prog-device and can be configured via the CWR register.

Questions:
1- What is meant by a prog-device ?
2- illustrate the advantage of a prog-device via a design.
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