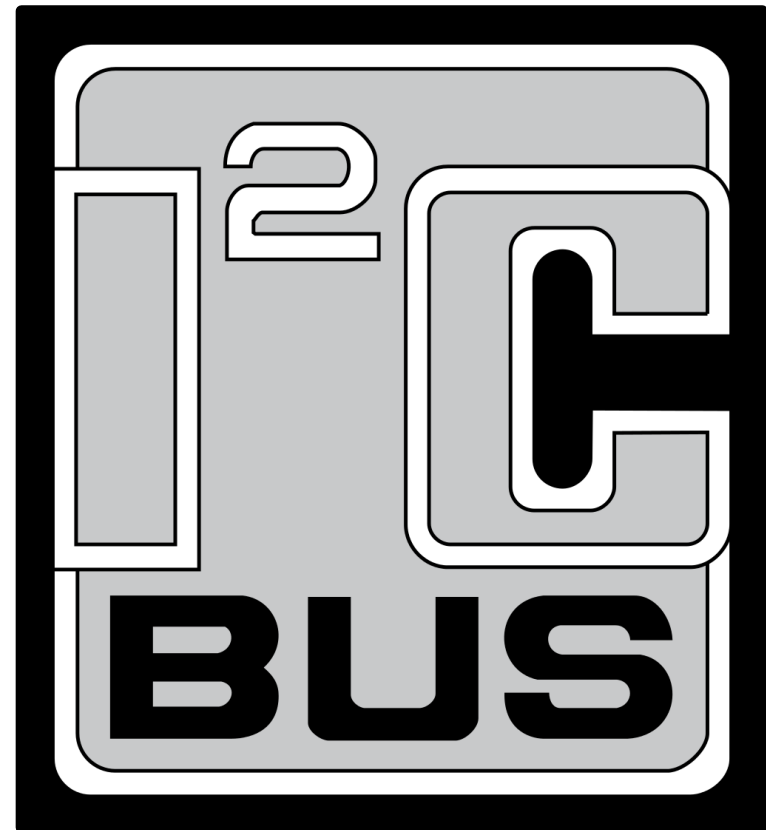


# Arduino en I2C – Dag 1

# I2C Bus

- ▶ Inter Integrated Circuit
- ▶ Intern bussysteem voor koppelen van IC's.
- ▶ 2 draads bus
- ▶ Master-Slave(s)
- ▶ 1982 Philips (NXP)
- ▶ Flexibel



# Welke I2C slaves ken je?

▶ .....

▶ .....

▶ .....

▶ .....


▶ .....

▶ .....

▶ .....

▶ .....

# Welke I2C slaves ken je?

- ▶ Kleur
  - ▶ Touch
  - ▶ Camera
  - ▶ Luchtdruk
  - ▶ VFO
  - ▶ CO2
  - ▶ GPS
  - ▶ PS2X
- 

# Welke I2C slaves ken je?

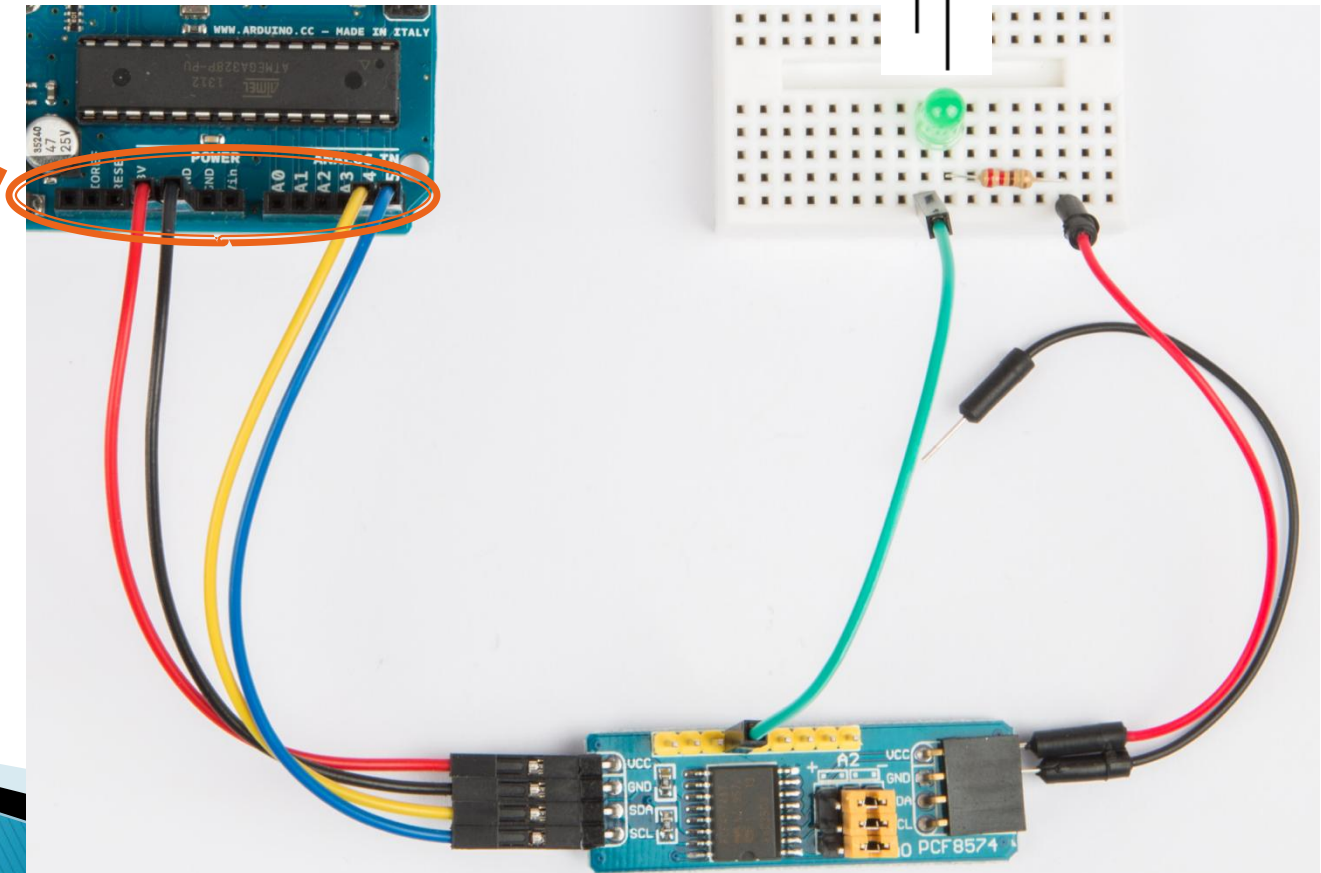
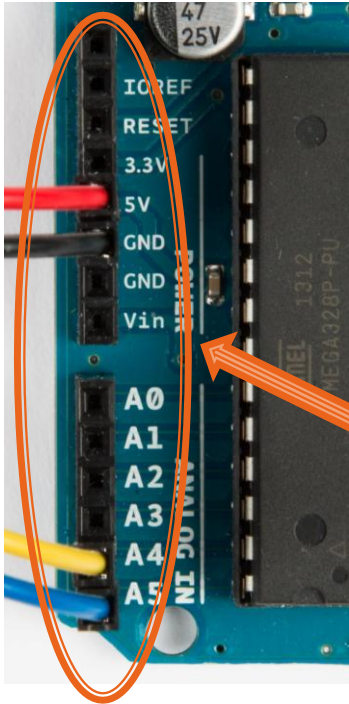
- ▶ Kleur
  - ▶ Touch
  - ▶ Camera
  - ▶ Luchtdruk
  - ▶ VFO
  - ▶ CO2
  - ▶ GPS
  - ▶ PS2X
  - ▶ ADC
  - ▶ DAC
  - ▶ IO
  - ▶ Accelero
  - ▶ Gyro
  - ▶ Magneto
  - ▶ Oled driver
  - ▶ Lcd driver
  - ▶ Pwm driver
  - ▶ Rtc
  - ▶ Afstand
  - ▶ Gesture
  - ▶ Temperatuur
  - ▶ Luchtvochtigheid
  - ▶ Motorsturing
  - ▶ Licht
  - ▶ Ram
  - ▶ Eeprom
- 

# I2C Blink a Led – Oefening (–)

Test met commando  
'blink' in terminal  
@ 115200 baud



Zowel NL en CR ▼ 115200 baud ▼



# I2C Blink a Led – Wire class



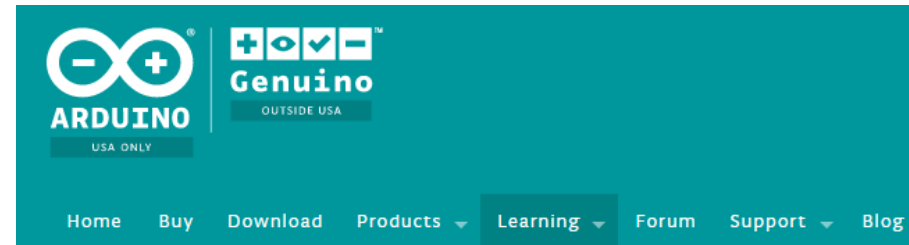
```
#include <Wire.h>
```

```
void setup() {  
  Serial.begin(115200);  
  fdevopen( &my_putc, 0);
```

```
PrintTkMsg();
```



```
Wire.begin();
```



Reference [Language](#) | [Libraries](#) | [Comparison](#) | [Changes](#)

## Wire Library

This library allows you to communicate with I2C / TWI devices. On the Arduino boards with the R3 layout (1.0 pinout), the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. The Arduino Due has two I2C / TWI interfaces SDA1 and SCL1 are near to the AREF pin and the additional one is on pins 20 and 21.

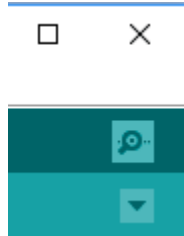
As a reference the table below shows where TWI pins are located on various Arduino

<https://www.arduino.cc/en/Reference/Wire>

<http://playground.arduino.cc/Main/WireLibraryDetailedReference>

# I2C Blink a Led – Oefening (a)

- ▶ Zoek plaats 'oefening a'
- ▶ Voeg 3 Wire-aanroepen toe
- ▶ Test met commando 'a' in terminal.



Zowel NL en CR ▼ 115200 baud ▼

i2c\_master\_ws1

I2CmTk

```
case 'a' :
```

```
{
```

```
// oefening a
```

```
Wire.beginTransaction(0x38);
```

```
Wire.write(0x00);
```

```
Wire.endTransmission();
```

```
break;
```

```
}
```

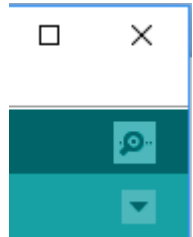


# I2C Blink a Led – Oefening (a en b)

i2c\_master\_ws1

I2CmTk

```
case 'a' :  
{  
    // Oefening a  
    Wire.beginTransmission(0x38);  
    Wire.write(0x00);  
    Wire.endTransmission();  
    break;  
}
```



Zowel NL en CR ▾

115200 baud ▾

i2c\_master\_ws1

I2CmTk

```
case 'b' :  
{  
    // Oefening b  
    Wire.beginTransmission(PCF8574A_I2C_ADDRESS);  
    Wire.write(0xFF);  
    Wire.endTransmission();  
    break;  
}
```

# I2C Blink a Led – Resultaat

i2c\_master\_ws1

I2CmTk

```
#include <Wire.h>
```

```
// I2C Slave adressen van de workshop.
```

```
#define PCF8574A_I2C_ADDRESS 0x38
```

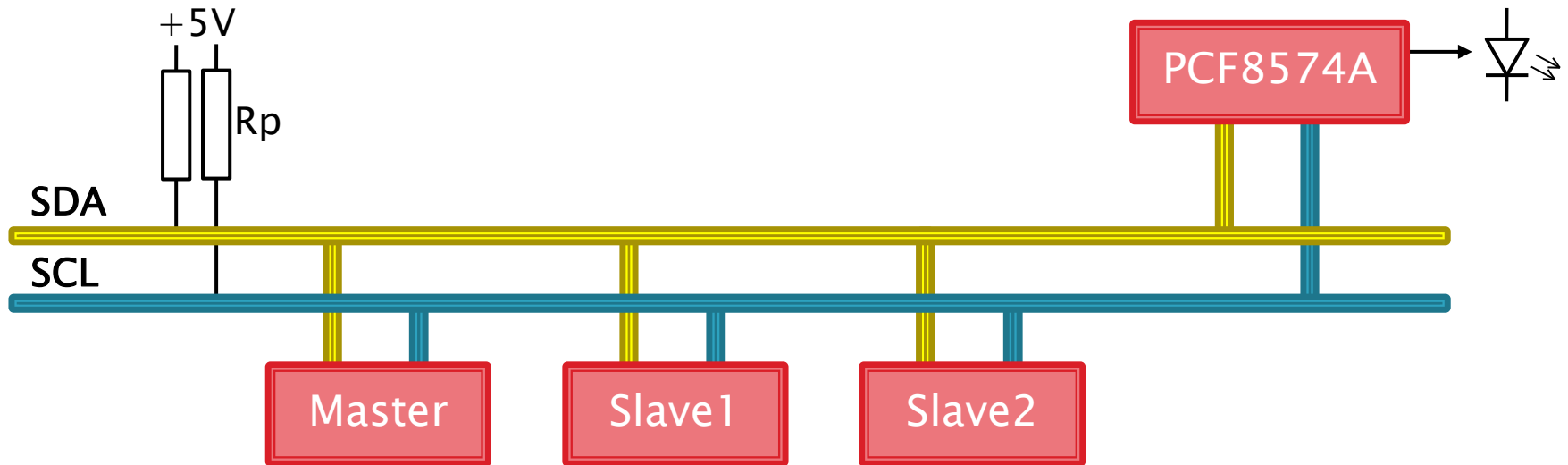
```
#define EEPROM_I2C_ADDRESS 0x57
```

```
#define DS3231_I2C_ADDRESS 0x68
```

```
#define ARDUINO_I2C_ADDRESS 0x44
```

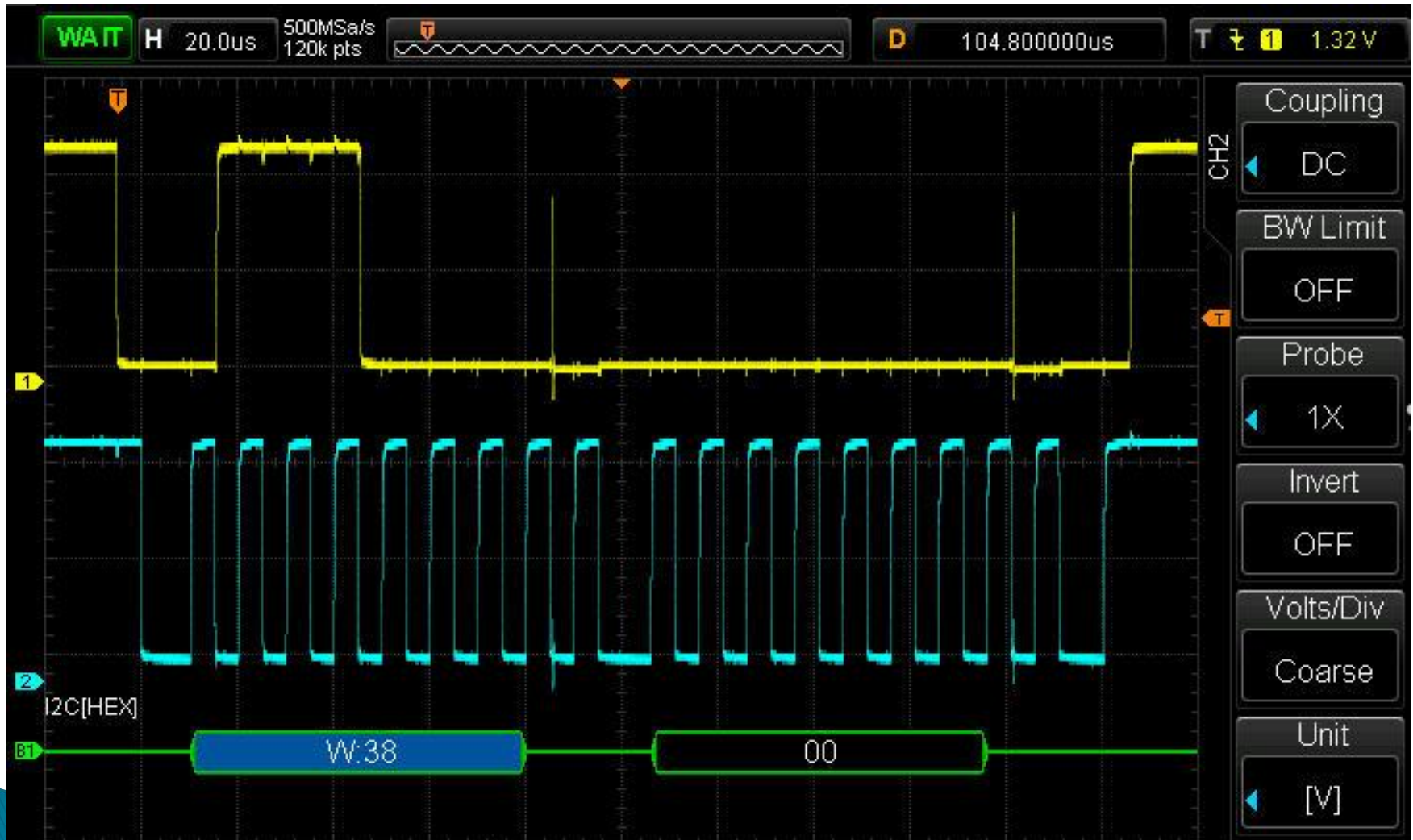
# I2C Bus

```
Wire.beginTransmission(0x38);  
Wire.write(0x00);  
Wire.endTransmission();
```

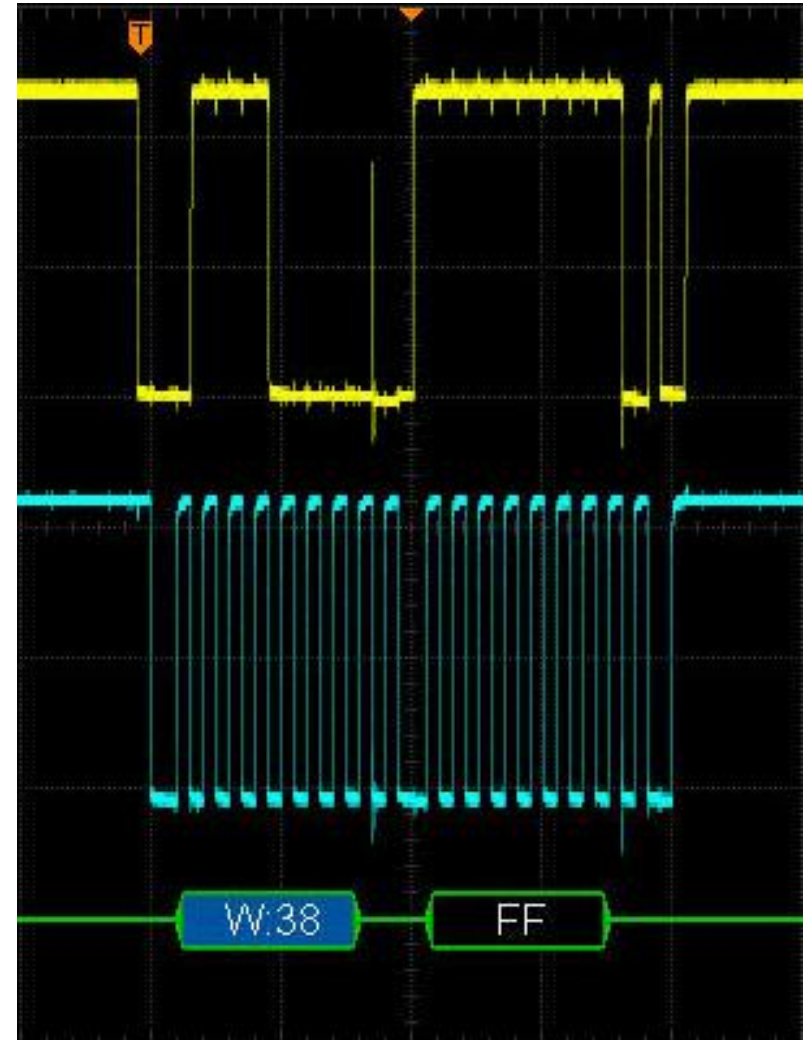
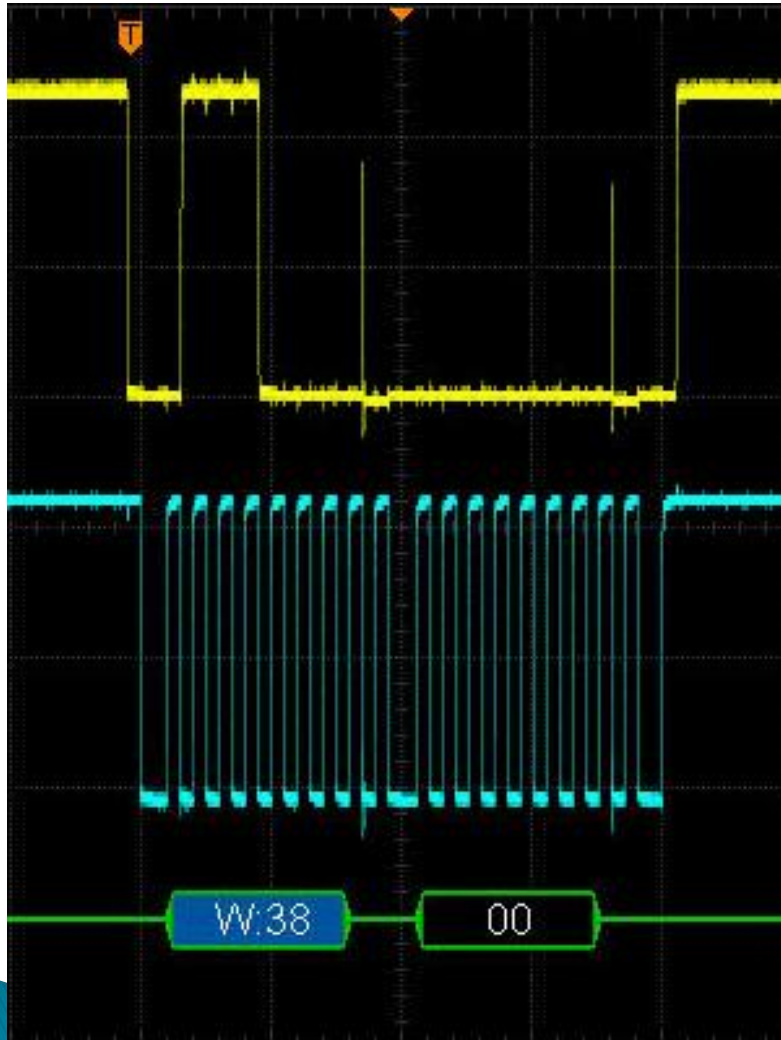


# I2C Bericht

```
Wire.beginTransaction(0x38);  
Wire.write(0x00);  
Wire.endTransmission();
```



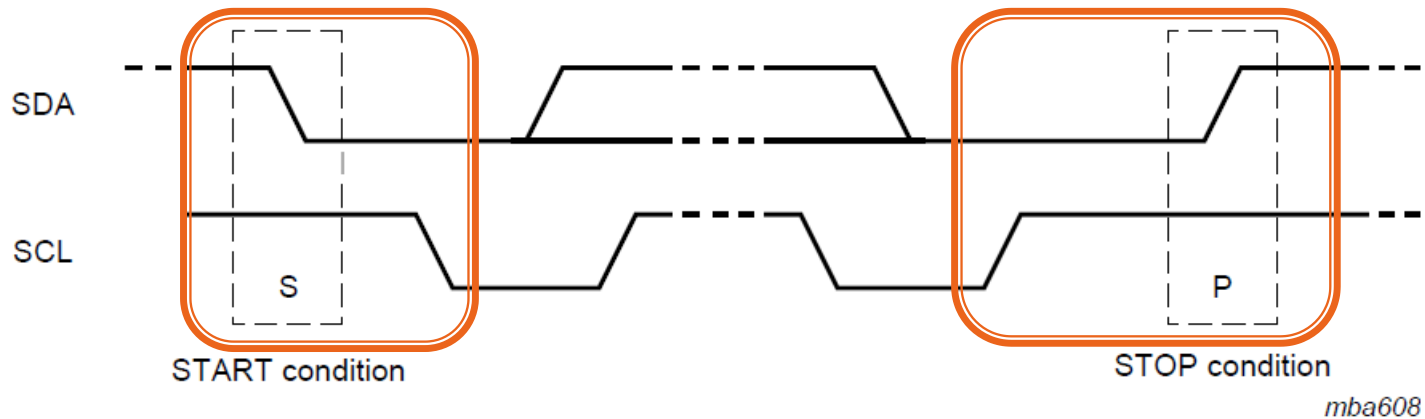
# I2C Bericht (2)



# I2C – De details

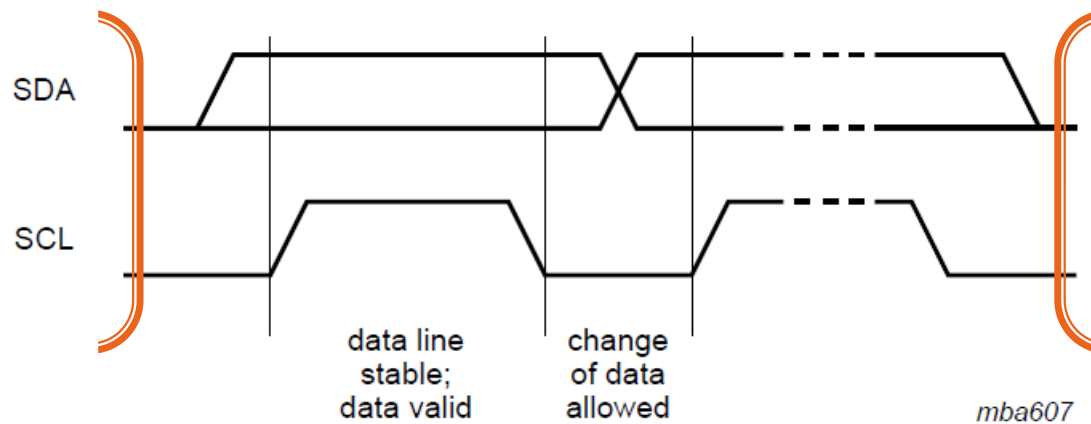
- ▶ Start & stop
- ▶ Bit transfer & acknowledgement
- ▶ Addressing & read/write

# Start & Stop



**Fig 12. Definition of START and STOP conditions**

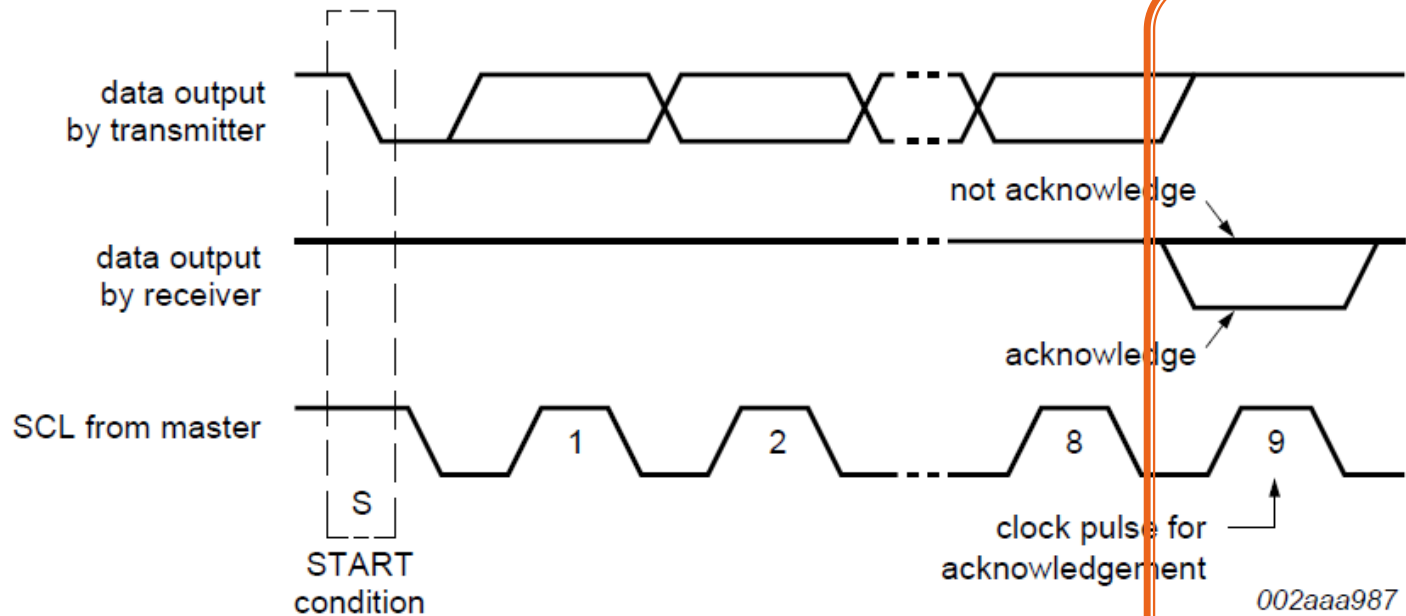
# Bit transfer



**Fig 11. Bit transfer**

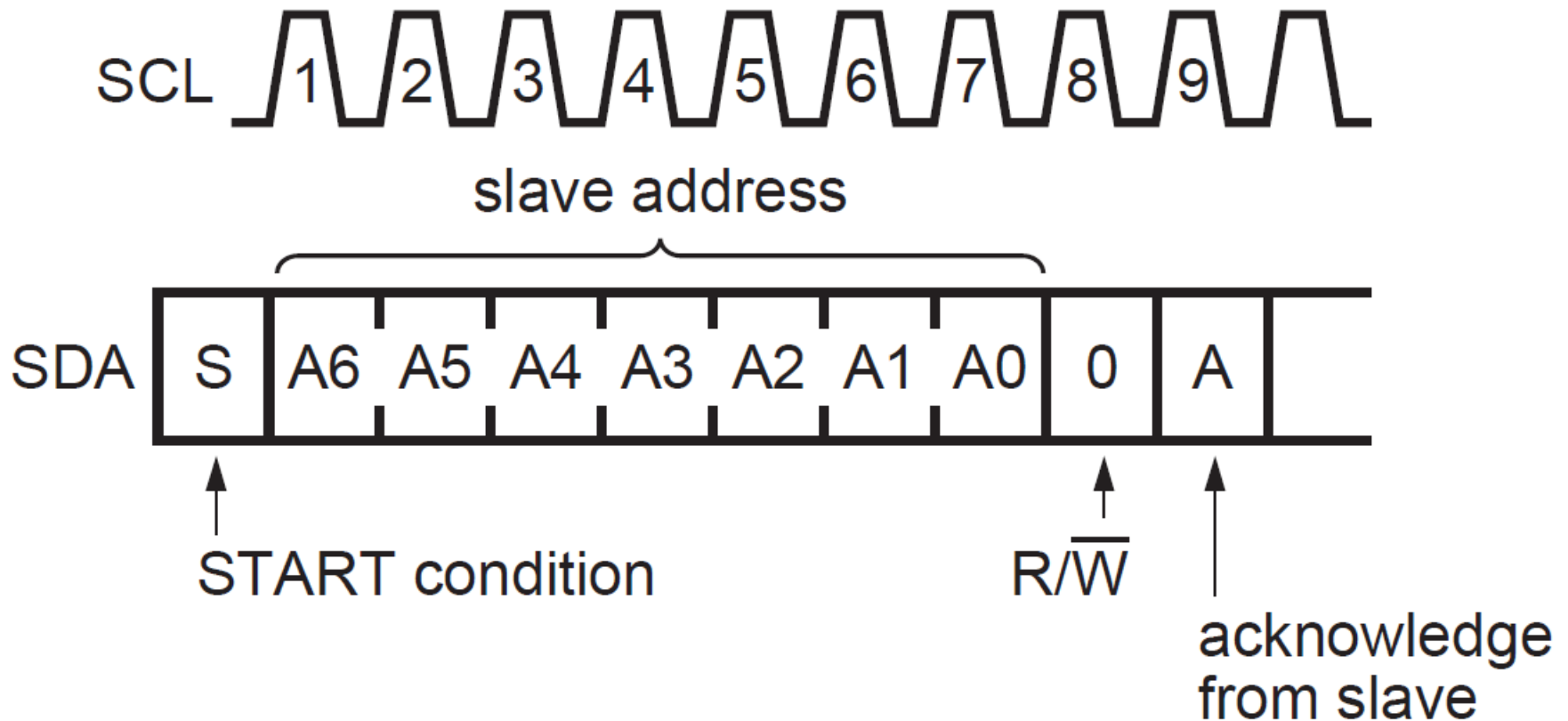


# Acknowledgement



**Fig 14. Acknowledgement on the I<sup>2</sup>C-bus**

# Adres (write)



# Adressering

**Table 5. PCF8574A address map**

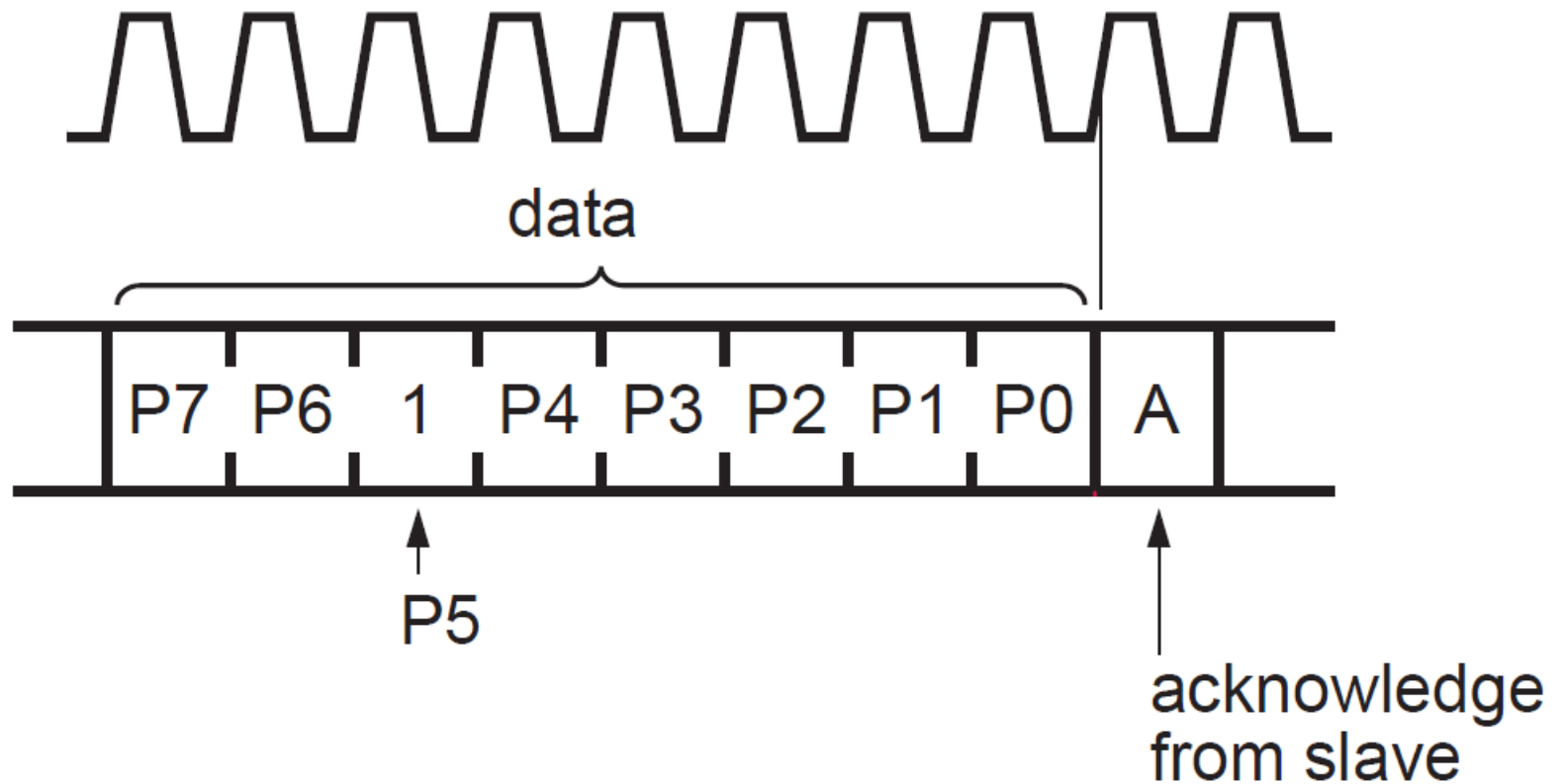
| Pin connectivity |                 |                 | Address of PCF8574A |    |    |    |    |    |    |     | Address byte value |      | 7-bit hexadecimal address without R/W |
|------------------|-----------------|-----------------|---------------------|----|----|----|----|----|----|-----|--------------------|------|---------------------------------------|
| A2               | A1              | A0              | A6                  | A5 | A4 | A3 | A2 | A1 | A0 | R/W | Write              | Read |                                       |
| V <sub>SS</sub>  | V <sub>SS</sub> | V <sub>SS</sub> | 0                   | 1  | 1  | 1  | 0  | 0  | 0  | -   | 70h                | 71h  | 38h                                   |
| V <sub>SS</sub>  | V <sub>SS</sub> | V <sub>DD</sub> | 0                   | 1  | 1  | 1  | 0  | 0  | 1  | -   | 72h                | 73h  | 39h                                   |
| V <sub>SS</sub>  | V <sub>DD</sub> | V <sub>SS</sub> | 0                   | 1  | 1  | 1  | 0  | 1  | 0  | -   | 74h                | 75h  | 3Ah                                   |
| V <sub>SS</sub>  | V <sub>DD</sub> | V <sub>DD</sub> | 0                   | 1  | 1  | 1  | 0  | 1  | 1  | -   | 76h                | 77h  | 3Bh                                   |
| V <sub>DD</sub>  | V <sub>SS</sub> | V <sub>SS</sub> | 0                   | 1  | 1  | 1  | 1  | 0  | 0  | -   | 78h                | 79h  | 3Ch                                   |
| V <sub>DD</sub>  | V <sub>SS</sub> | V <sub>DD</sub> | 0                   | 1  | 1  | 1  | 1  | 0  | 1  | -   | 7Ah                | 7Bh  | 3Dh                                   |
| V <sub>DD</sub>  | V <sub>DD</sub> | V <sub>SS</sub> | 0                   | 1  | 1  | 1  | 1  | 1  | 0  | -   | 7Ch                | 7Dh  | 3Eh                                   |
| V <sub>DD</sub>  | V <sub>DD</sub> | V <sub>DD</sub> | 0                   | 1  | 1  | 1  | 1  | 1  | 1  | -   | 7Eh                | 7Fh  | 3Fh                                   |

# Adressering (PCF8574 zonder A)

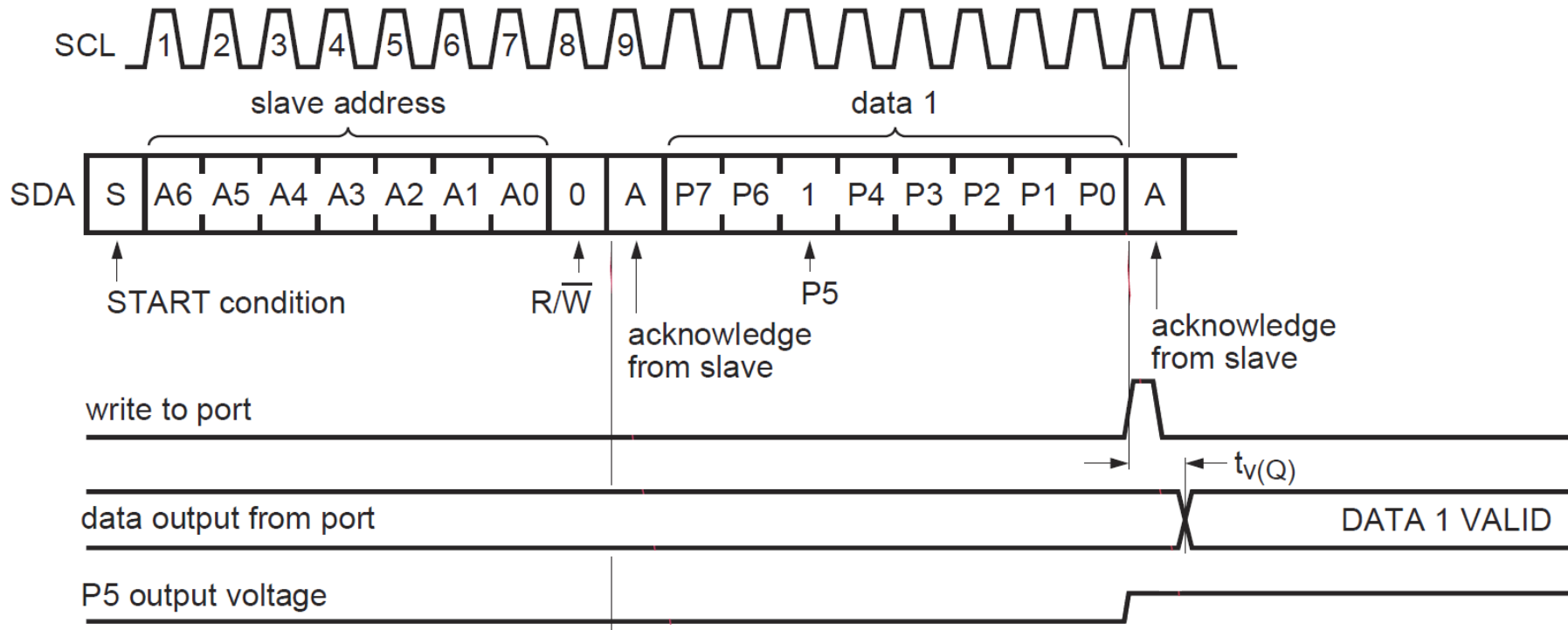
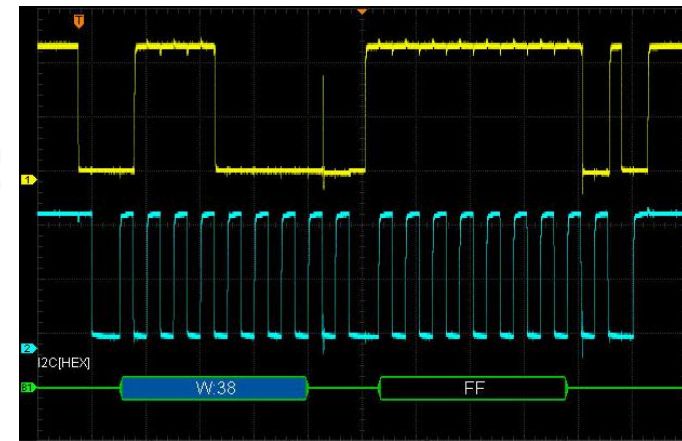
Table 4. PCF8574 address map

| Pin connectivity |                 |                 | Address of PCF8574 |    |    |    |    |    |    |     | Address byte value |      | 7-bit hexadecimal address without R/W |
|------------------|-----------------|-----------------|--------------------|----|----|----|----|----|----|-----|--------------------|------|---------------------------------------|
| A2               | A1              | A0              | A6                 | A5 | A4 | A3 | A2 | A1 | A0 | R/W | Write              | Read |                                       |
| V <sub>SS</sub>  | V <sub>SS</sub> | V <sub>SS</sub> | 0                  | 1  | 0  | 0  | 0  | 0  | 0  | -   | 40h                | 41h  | 20h                                   |
| V <sub>SS</sub>  | V <sub>SS</sub> | V <sub>DD</sub> | 0                  | 1  | 0  | 0  | 0  | 0  | 1  | -   | 42h                | 43h  | 21h                                   |
| V <sub>SS</sub>  | V <sub>DD</sub> | V <sub>SS</sub> | 0                  | 1  | 0  | 0  | 0  | 1  | 0  | -   | 44h                | 45h  | 22h                                   |
| V <sub>SS</sub>  | V <sub>DD</sub> | V <sub>DD</sub> | 0                  | 1  | 0  | 0  | 0  | 1  | 1  | -   | 46h                | 47h  | 23h                                   |
| V <sub>DD</sub>  | V <sub>SS</sub> | V <sub>SS</sub> | 0                  | 1  | 0  | 0  | 1  | 0  | 0  | -   | 48h                | 49h  | 24h                                   |
| V <sub>DD</sub>  | V <sub>SS</sub> | V <sub>DD</sub> | 0                  | 1  | 0  | 0  | 1  | 0  | 1  | -   | 4Ah                | 4Bh  | 25h                                   |
| V <sub>DD</sub>  | V <sub>DD</sub> | V <sub>SS</sub> | 0                  | 1  | 0  | 0  | 1  | 1  | 0  | -   | 4Ch                | 4Dh  | 26h                                   |
| V <sub>DD</sub>  | V <sub>DD</sub> | V <sub>DD</sub> | 0                  | 1  | 0  | 0  | 1  | 1  | 1  | -   | 4Eh                | 4Fh  | 27h                                   |

# Data (write)

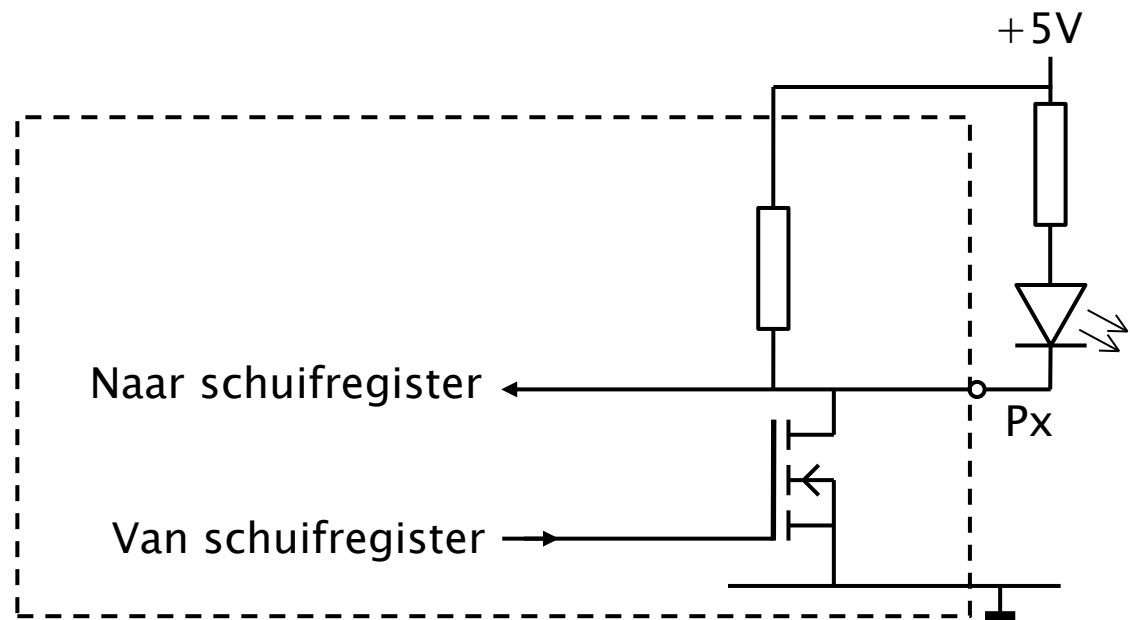


# Complete write cycle



# PCF8574 Input/output

- ▶ Sink current: 10–25 mA/pin (80–100/pckg)
- ▶ Pull-up current 30–300  $\mu\text{A}$  / pin
- ▶ Boost pull-up 1 mA (tijdens Ack)

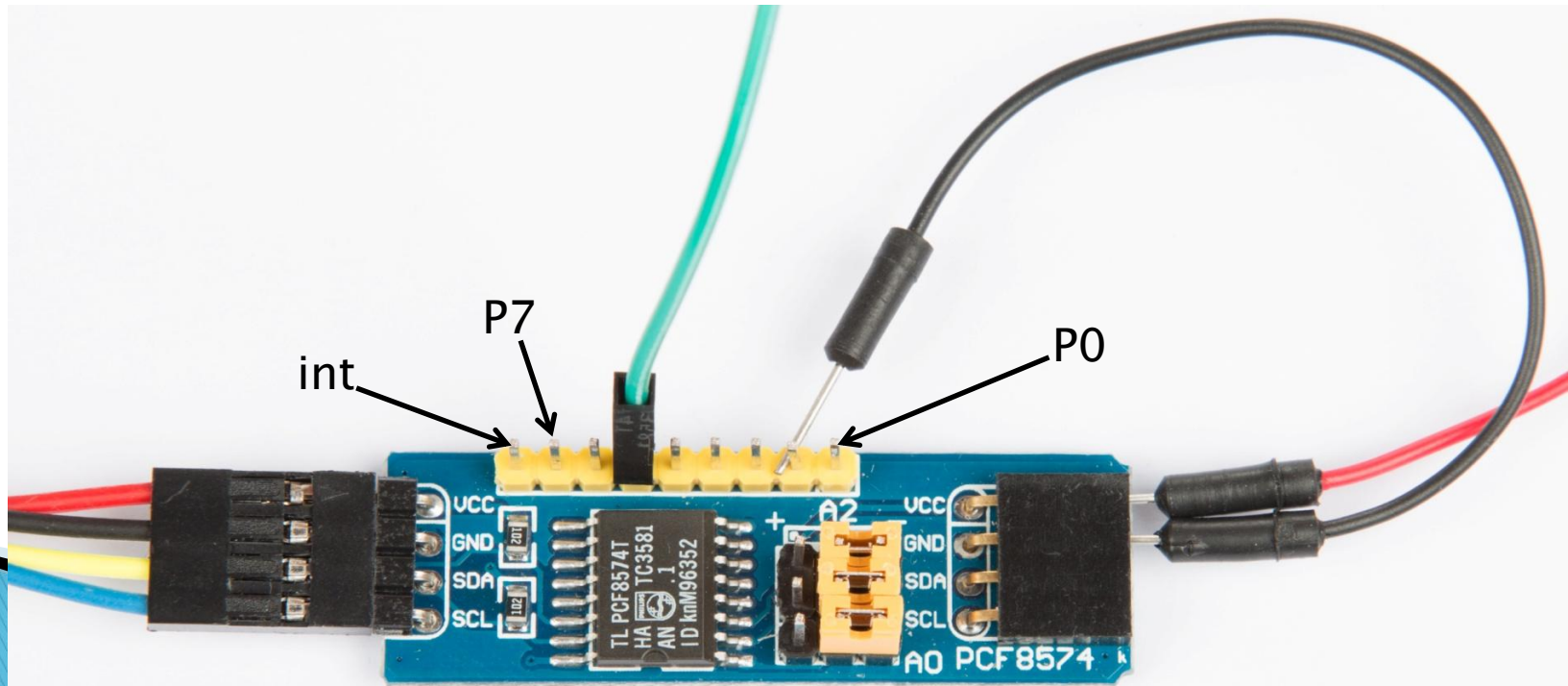


# PCF8574 – Oefening (c)

i2c\_master\_ws1

I2CmTk

```
case 'c' :  
{  
    // Oefening c  
    int nr = Wire.requestFrom(PCF8574A_I2C_ADDRESS, 1); // vraag 1 byte op  
    if (nr == 1) {  
        int data = Wire.read();  
        printf("Gelezen: %d (0x%02x)\n", data, data);  
    } else {  
        printf("Leesfout\n");  
    }  
    break;  
}
```





# PCF8574 – Resultaat (c)

Aantal bytes  
daadwerkelijk gelezen

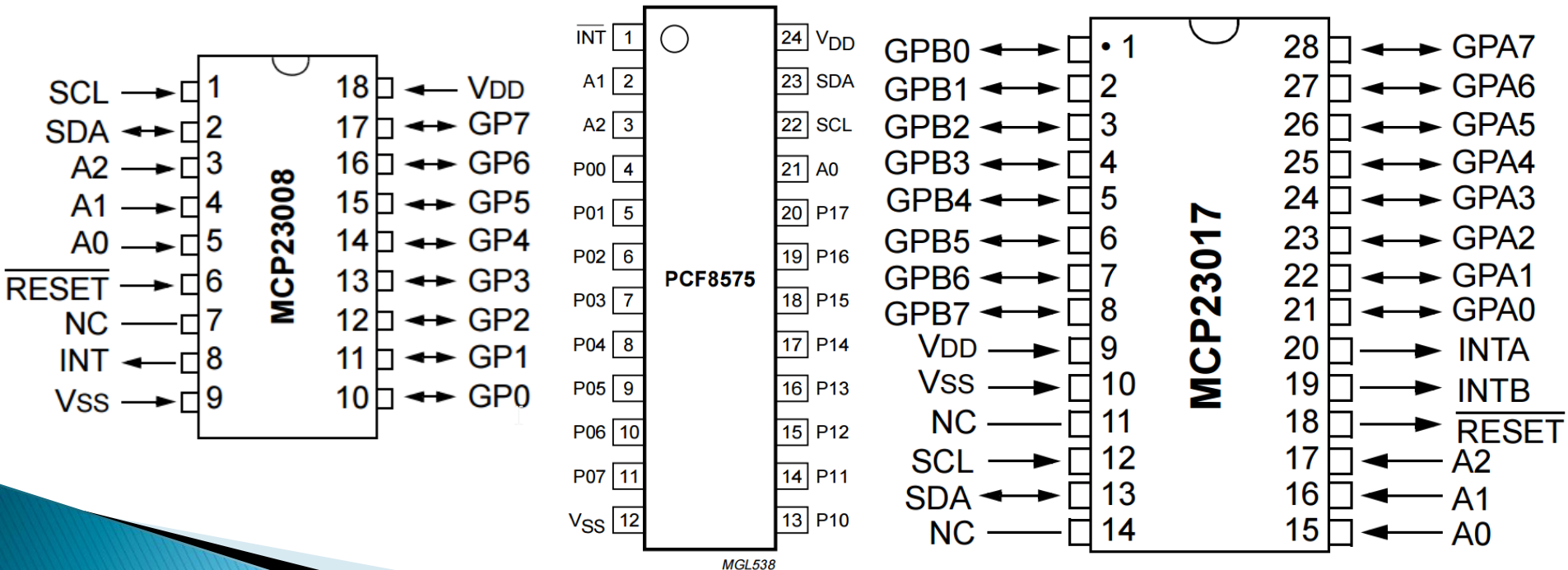
Aantal bytes  
gevraagd

```
i2c_master_ws1  CmTk
case 'c' :
{
    // Defining c
    int nr = Wire.requestFrom(PCF8574A_I2C_ADDRESS, 1);
    if (nr == 1) {
        int data = Wire.read();
        printf("Gelezen: %d (0x%02x)\n", data, data);
    } else {
        printf("Lees fout\n");
    }
    break;
}
```

Communicatie goed gegaan?

# I2C IO chips

- ▶ PCF8575 – 16 bit versie van de PCF8584
- ▶ MCP23008 / MCP23017 – 8/ 16 bits, harde output, pull-up optioneel.



# Standaardisatie

| Signaal  | Kleur |
|----------|-------|
| GND / 0V | Zwart |
| VCC / 5V | Rood  |
| I2C SDA  | Geel  |
| I2C SCL  | Blauw |

| Module       | 1 | 2 | 3 | 4 |
|--------------|---|---|---|---|
| PCF8574      |   |   |   |   |
| Uno          |   |   |   |   |
| RTC          |   |   |   |   |
| Joep         |   |   |   |   |
| Eeprom (bl)  |   |   |   |   |
| Eeprom (rd)  |   |   |   |   |
| BH1750       |   |   |   |   |
| OLED Display |   |   |   |   |

# Huiswerk: gebruik de PCF8574

1. Arduino LED (pin 13) bedienen met input 0 van de PCF8574 (oefening 'y').
2. PCF8574 LED laten knipperen (oefening 'z')
3. De combinatie van (1) en (2)
4. Bekijk de datasheet van de AT24C32 eeprom.



**2-Wire  
Serial EEPROM**

32K (4096 x 8)

**AT24C32**