



# STM32 entry-level graphics

Smartphone-like GUIs on a budget



# An appealing interface to enhance your product



# Upgrade your small display

Replace traditional segment displays with modern graphical display solutions

Old segment solution



New **graphics** solution



- Smartphone-inspired user experience
- Low power for long battery life
- Minimal increase in BOM costs

# Possible use cases for STM32 entry-level graphics



Home appliances



Professional & industry



Home automation

*\*Non exhaustive list, with many more applications possible.*

*Entry-level graphics: Up to 3.5" SPI displays with G-RAM, run by mainstream STM32 MCUs*

# User stories / references



STM32G07x



STM32G071/  
STM32C091



# Build entry-level graphic solutions with STM32 hardware and software



# STM32 for entry-level graphics

## Smart devices addressing user expectations

With STM32 and TouchGFX, create innovative GUI designs for better IoT solutions



# TouchGFX

- Deliver smart, connected hardware
- Design intuitive UIs for maximum product value
- Enable dynamic information changes on hardware
- Provide easy access to multiple device functionalities
- Display error messages and links instead of error codes

## A great user experience fostering more interactions with the IoT device

Opportunities for a more impactful GUI than segment displays



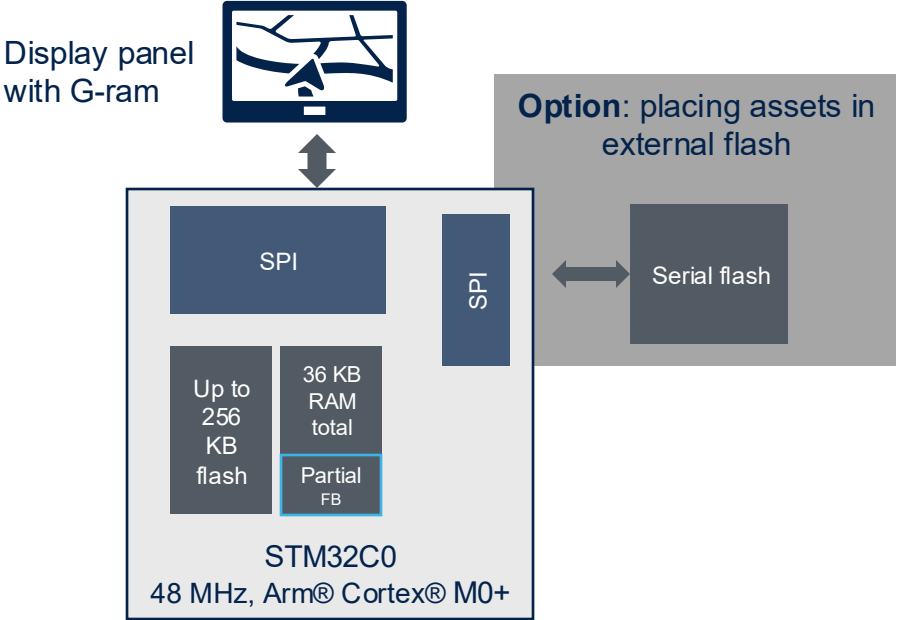
- Create an exciting and impactful entry-level GUI
- Use intuitive and simple animations
- Support tactile buttons or touch displays



# STM32 hardware for entry-level graphics

## TouchGFX supported

| STM32 ultra-low-power MCUs | STM32 mainstream MCUs | STM32 wireless MCUs | STM32 high-performance MCUs |
|----------------------------|-----------------------|---------------------|-----------------------------|
| STM32U0                    | STM32C0               | STM32WBA            | STM32H503                   |
| STM32U3                    | STM32G0               | STM32WB             |                             |



Typical hardware setup for entry-level applications  
NB: No external RAM







# STM32 hardware for entry-level graphics

| Graphic performance                       | ENTRY-LEVEL                                               |                                             |                                                     |                                            |                                            |                                              |                                            |
|-------------------------------------------|-----------------------------------------------------------|---------------------------------------------|-----------------------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------------------------|--------------------------------------------|
| Display                                   | Up to 320x240 – SPI interface, G-RAM, touch, and no-touch |                                             |                                                     |                                            |                                            |                                              |                                            |
| STM32 MCU                                 | STM32U0                                                   | STM32U3                                     | STM32C0                                             | STM32G0                                    | STM32H503                                  | STM32WBA                                     | STM32WB                                    |
| Development kits- TouchGFX supported      | Nucleo-U083RC<br>+<br>X-NUCLEO-GFX01M2                    | Nucleo-U385RG-Q +<br>RVA15MD*               | Nucleo-C092RC<br>+<br>RVA15MD*/<br>X-NUCLEO-GFX01M2 | Nucleo-G071RB<br>+<br>X-NUCLEO-GFX01M2     | Nucleo-H503RB<br>+<br>X-NUCLEO-GFX01M2     | Nucleo-WBA65RI<br>+<br>RVA15MD*              | Nucleo-WB55RG<br>+<br>X-NUCLEO-GFX01M2     |
| Main features<br><i>Max memory listed</i> | CM0+, 56 MHz<br>40 KB RAM<br>256 KB flash                 | CM33, 96 MHz<br>256 KB RAM<br>1000 KB flash | CM0+, 48 MHz<br>36 KB RAM<br>256 KB flash           | CM0+, 64 MHz<br>144 KB RAM<br>512 KB flash | CM33, 250 MHz<br>32 KB RAM<br>128 KB flash | CM33, 100 MHz<br>512 KB RAM<br>1000 KB flash | CM4, 64 MHz<br>256 KB RAM<br>1000 KB flash |
| Framebuffer details                       | Partial in internal RAM, starting from 6 KB               |                                             |                                                     |                                            |                                            | Full or partial in internal RAM              |                                            |
| Asset storage (flash memory)              | Internal or<br>External SPI                               | Internal or<br>External (Q)SPI              | Internal or<br>External SPI                         | Internal or<br>External SPI                | Internal or<br>External (Q)SPI             | Internal or<br>External SPI                  | Internal or<br>External (Q)SPI             |

\*Riverdi add-on kit: RVA15MD, order from Riverdi sales channels: [1.54" STM32 Nucleo-64 display kit - Riverdi](#)



**Inexpensive, modern GUI made possible thanks to TouchGFX**



## Partial framebuffer

- Minimizing the RAM needed for image building
  - Configurable partial framebuffer size and numbers
- Smart partial screen updates
  - Higher UI performance by optimizing the number of possible partial updates

**Image and font compression features to save flash usage for assets**

**Support for inexpensive non-memory mapped (NAND) SPI flash**

## Low memory footprint (TouchGFX library)

When using partial framebuffer, typical memory footprint for small app:

- Internal flash: 100 KB (TouchGFX app code)
- External SPI flash: 1000 KB (GFX assets)
- Internal RAM: 22 KB (partial framebuffers 12 KB + TouchGFX 10 KB)

# STM32 software for entry-level graphics

**Inexpensive, modern GUI made possible thanks to TouchGFX**

## TouchGFX compression features:

- High compression – normal 50 to 95%
- Lossless
- Minimum performance penalty
- Bitmap **image** compression
  - L8 image format (max 256 colors per image)
  - Compression of L8 images (for example, L8 RLE run-length encoding)
  - Compression of RGB565 / ARGB8888 (C-RGB)
- Bitmap **font** compression
  - Bitmap fonts in 4 bpp (standard format for bitmap fonts)
  - RLE compression

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# STM32 software for entry-level graphics

**Inexpensive, modern GUI made possible thanks to TouchGFX**

## Limitations for STM32 entry-level graphics

- Curtain effect can appear doing full screen updates (partial screen updates) and advanced texture mapping is not possible
- Display resolution up to approx. 320x240
- Need displays with embedded G-RAM  
NB: standard in small displays

## Partial framebuffer

- Minimizing the RAM needed for image building
  - Configurable partial framebuffer size and numbers
- Smart partial screen updates
  - Higher UI performance by optimizing the number of possible partial updates

## Image and font compression features to save flash usage for assets

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- ✓ **Hardware:**  
TSD 1.3" 240x240 round rotary knob display – [order here](#)
- ✓ STM32C091 – 256KB flash, 36KB RAM
- ✓ 64Mbit SPI flash
- ✓ Including an adapter board for flashing and debugging



### Lite: basic graphics / one chip solution

- To save flash:
  - Simple icons/images for high compression
  - All images are compressed L8
  - Boxes instead of images used for background
- Memory footprint:
  - Internal RAM 18KB (FB= 6 K, TouchGFX 12 K)
  - **Internal flash: 123 KB** (TouchGFX code= 102 K, fonts=13K bitmaps= 8 K)

*This demo is available in TouchGFXDesigner under "Board specific demo"*

### Prime: refined graphics / dual-chip solution

- For refined graphics (requiring more flash):
  - Glow effect using gradients
  - Fading effects
  - Large fonts
  - Images (bitmaps) as background instead of boxes
- Memory footprint:
  - Internal RAM 18 KB (FB=6K, TouchGFX 12K)
  - Internal flash: 126 KB (TouchGFX code)
  - SPI flash: 1.370 KB (fonts + bitmaps)

*This demo is available in TouchGFXDesigner as TBS + demo*



# Reach a cost-effective solution with STM32



# Save BOM costs

## BOM cost estimation *PCB with all electronics*

| Component                         | 10k volume<br>POS (USD) |
|-----------------------------------|-------------------------|
| 2.4" color TFT display (no touch) | 2.00                    |
| STM32C091 32 pins MCU (10 K)      | 0.83                    |
| SPI flash (4 Mbytes)              | 0.52                    |
| Other components                  | 2.40                    |
| PCB (2 layer)                     | 0.25                    |
| TouchGFX GUI library              | 0.00                    |
| <b>TOTAL BOM</b>                  | <b>6.00</b>             |



# Sourcing of small display with G-RAM ST partners:

| Display provider                                                                                                                                             | Location / contact                                                                                  | Distribution                                                                                                                             | TouchGFX-supported developer kits                                                                                                                                               | Comments                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
|  <p>TSD<br/><a href="https://www.tslcd.com/">https://www.tslcd.com/</a></p> | <p>China /<br/>Roger L.J.<br/><a href="mailto:roger@tslcd.com">roger@tslcd.com</a></p>              | <p><a href="#">Alibaba</a></p>                                                                                                           | <ul style="list-style-type: none"> <li>✓ Standalone module</li> <li>✓ 1.3 inch rotary knob display</li> <li>✓ TouchGFX-ready demo</li> </ul> <p><b>Discover the product</b></p> | <p>Adapter board included</p>                                                                                                         |
|  <p>Winstar</p>                                                             | <p>Taiwan<br/>Edward Chang<br/><a href="mailto:edward@winstar.com.tw">edward@winstar.com.tw</a></p> | <p>Distributor of Winstar displays direct sales, <a href="#">website</a>, LinkedIn, Digikey (USA)</p> <p><b>Discover the product</b></p> | <ul style="list-style-type: none"> <li>✓ Hardware integrated display module</li> <li>✓ 2.4 inch +STM32G0B1</li> </ul>                                                           | <p>Winstar GUI Builder<br/>Strong engineering team</p>                                                                                |
|  <p>Riverdi<br/><a href="http://www.riverdi.com">www.riverdi.com</a></p>   | <p>Poland<br/><a href="mailto:contact@riverdi.com">contact@riverdi.com</a></p>                      | <p>DigiKey, Mouser, and Direct</p> <p><b>Discover the product</b></p>                                                                    | <ul style="list-style-type: none"> <li>✓ Add-on 1.5" display module for STM32 Nucleo-64 kits.</li> <li>✓ TouchGFX-ready demo</li> </ul>                                         | <p>500 cd/m<sup>2</sup> 240×240 px IPS display, I<sup>2</sup>C PCAP touch with optical bonding.<br/>Full documentation available.</p> |

# Development kits





# STM32 entry-level GUI offer

## STM32 hardware



STM32WBA with  
NUCLEO-WBA65RI



STM32G0 with  
NUCLEO-G071RB



STM32U3 with  
Nucleo-U385RG-Q



STM32WB with  
NUCLEO-WB55RG



STM32C0 with  
NUCLEO-C071RB



STM32U0 with  
NUCLEO-U083RC



STM32H5 with  
NUCLEO-H503RB



Add graphic user interface (GUI)  
capability to STM32 Nucleo-64  
boards

[X-NUCLEO-GFX01M2](#)

+

OR



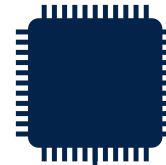
Pluggable STM32 Nucleo-64  
Display Kit, featuring a 1.54" SPI  
interface

[RVA15MD-NUC64A](#)

## STM32 software

A complete STM32 software offer,  
free of charge

TouchGFX +



Plug-and-play circular display  
with rotary switch featuring  
STM32 MCU

[Rotary Knob display](#)



# TSD knob display module

## Entry-level graphics on ready-to-use display kit

### Knob display with encoder switch – Adaptor board for development

#### Software available:

TouchGFX out-of-the-box support

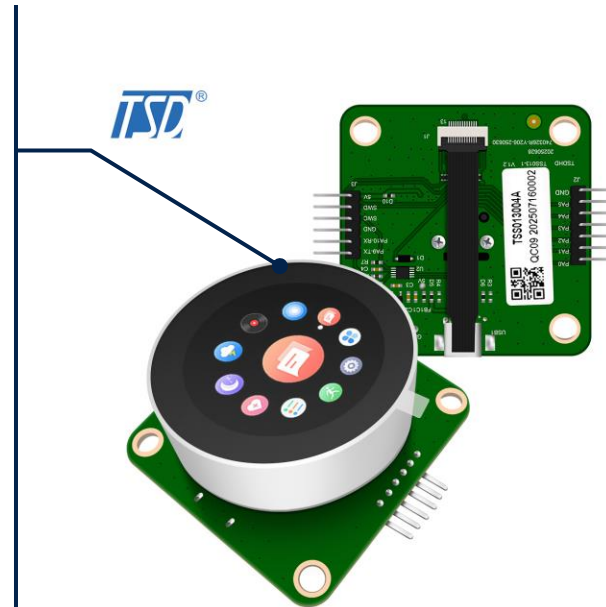
- Prime knob demo preloaded
- Prime and lite demos are available as full projects in TouchGFX Designer

#### Prime knob demo memory footprint:

- Internal flash: 121 KB (TouchGFX app + text)
- External SPI flash: 1370 KB (GFX assets)
- Internal RAM: 18 KB (partial framebuffer (6K) + TouchGFX (12k))

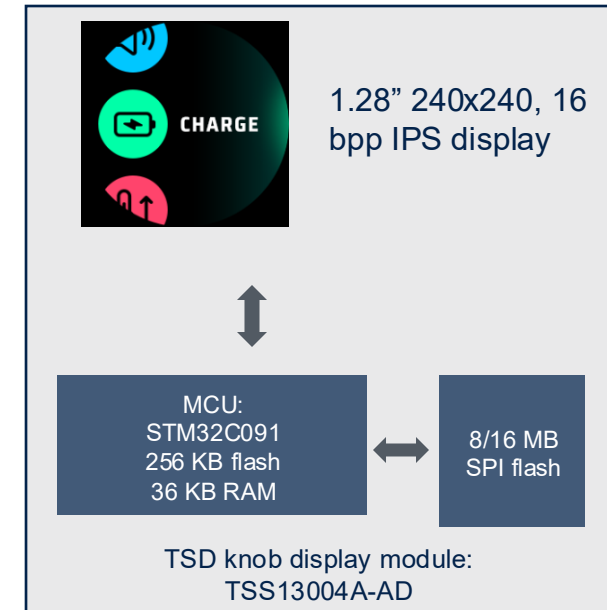
#### Lite knob demo memory footprint:

- Internal flash: 123 KB (TouchGFX code= 102 K, fonts=13 K bitmaps=8 K)
- Internal RAM 18 KB (FB=6 K, TouchGFX 12 K)



TSD knob display  
TSS13004A-AD:

[Learn more](#)  
[Order](#)







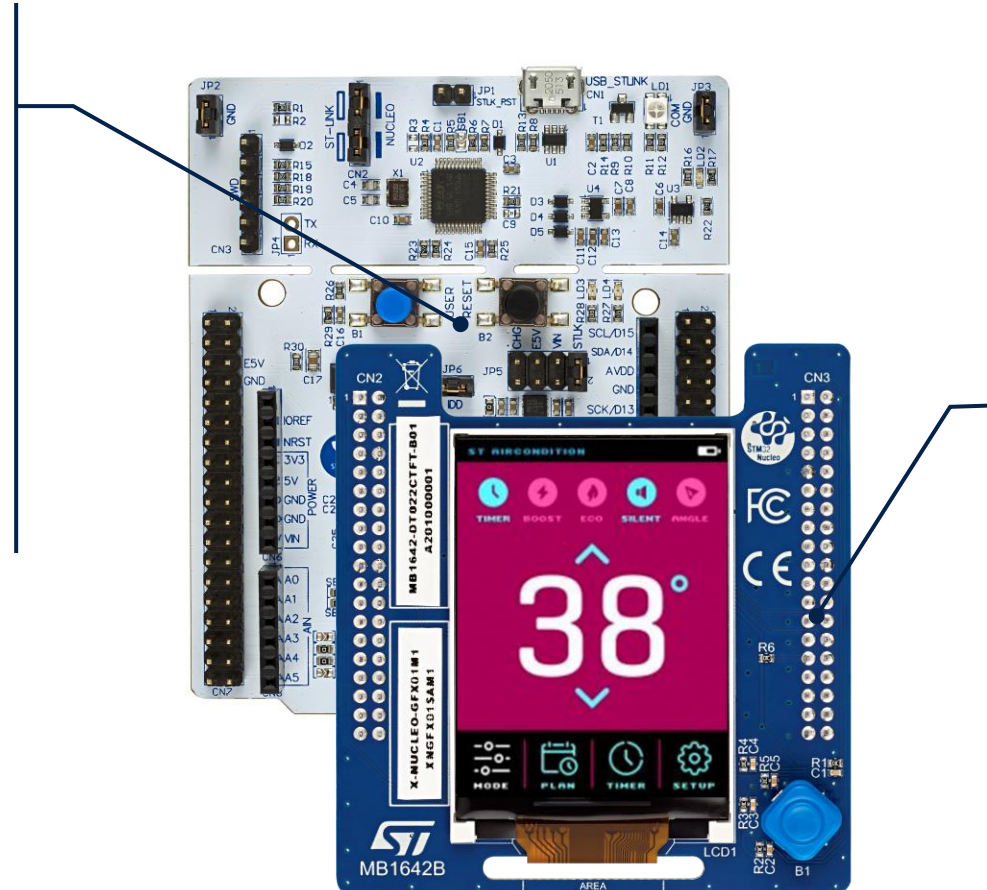
# X-NUCLEO SPI display expansion

Out-of-the-box **TouchGFX Designer** support:

**X-NUCLEO-GFX01M2**

- + NUCLEO-G071RB
- + NUCLEO-C071RB
- + NUCLEO-U083RC
- + NUCLEO-WB55RG
- + NUCLEO-H503RB

Available demos: 320x240



## X-NUCLEO-GFX01M2 expansion display kit

- Supporting 64-pin Nucleo kits
- 2.2" SPI QVGA TFT LCD
  - Resolution: 240 x 320 px
  - Bit depth: 16 bpp
  - No touch
- 64 Mbit serial SPI flash
- Joystick for easy menu navigation

# Riverdi SPI display expansion

Out-of-the-box  
TouchGFXDesigner support:

- **RVA15MD-NUC64A**
- +
- NUCLEO-C092RC
- NUCLEO-C071RB
- NUCLEO-WBA65RI
- Nucleo-U385RG-Q

Available demos: 240x240



## RVA15MD-NUC64A addon display kit

- Supporting 64-pin Nucleo kits
- 1.5" IPS display
  - Resolution: 240 x 240 px
  - Bit depth: 16 bpp
  - Capacitive touch
- 64 Mbit serial SPI flash

# STM32U0

## Entry-level graphics with ultra-low-power MCU

Displays up to 3.5" and up to 320 x 240

- **NUCLEO-U083RC + X-NUCLEO-GFX01M2**

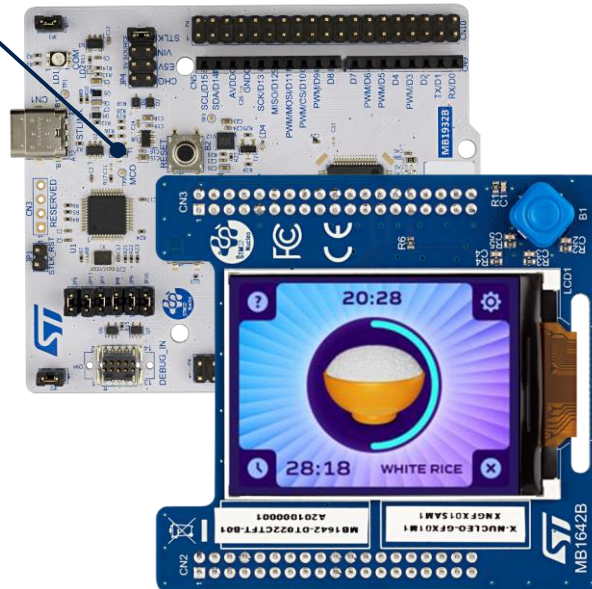
- 2.2" SPI QVGA 320 x 240 display

- **TouchGFXDesigner**

- Board specific demos in full source
- TouchGFX Board setup
- Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)

### STM32U0 running the rice cooker demo:

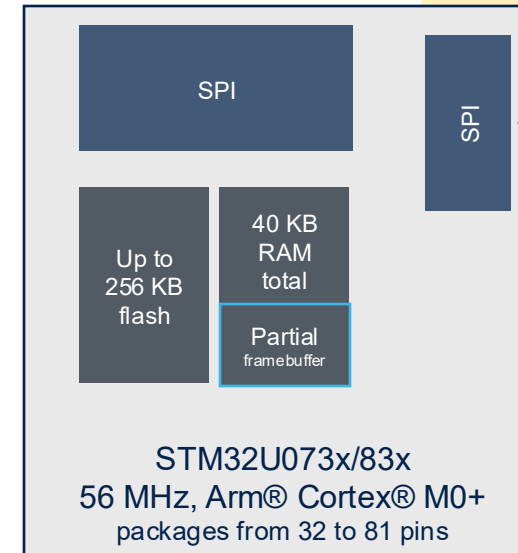
- Internal flash: 102 KB (TouchGFX app code)
- External SPI flash: 880 KB (GFX assets)
- Internal RAM: 20.8 KB (partial framebuffer + TouchGFX)



Display panel with G-ram



Optional for placing assets in external flash if needed



No external RAM due to partial framebuffer

# STM32C0

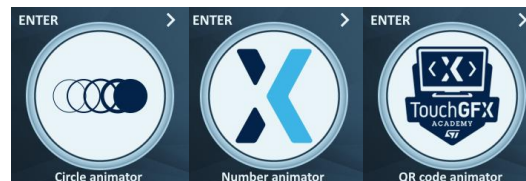
## Entry-level graphics with cost-effective MCU

Displays up to 3.5" - 320 x 240

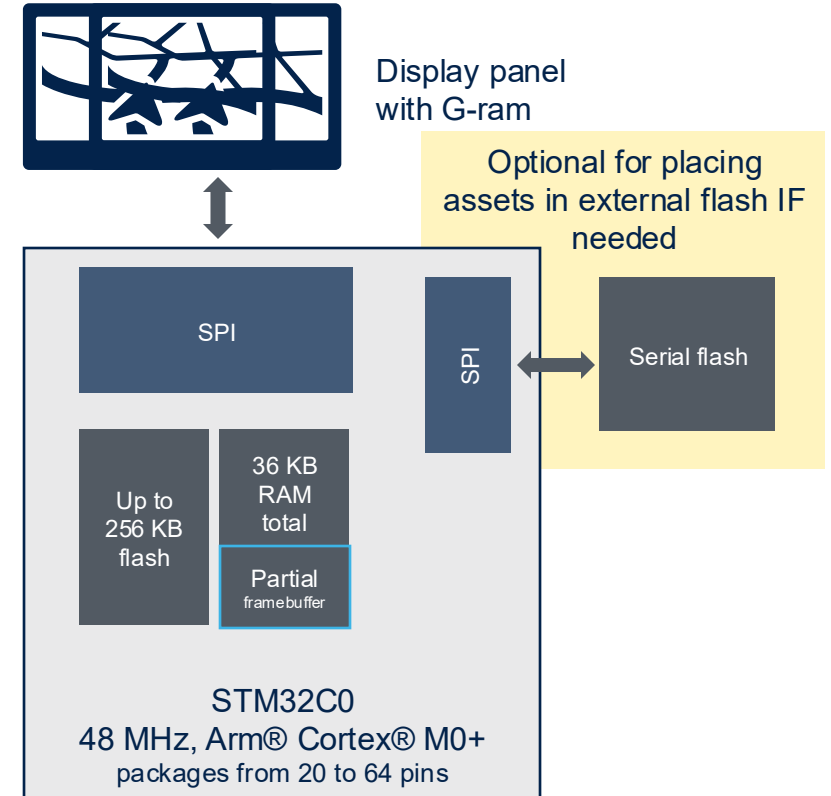
- **NUCLEO-C092RC + RVA15MD-NUC64A** (from Riverdi)
  - 1.5" SPI 240x240 touch display
- **Or X-NUCLEO-GFX01M2**
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)

### STM32C0 running demo 8:

- Internal flash: 19 KB (TouchGFX app + text)
- External SPI flash: 551 KB (GFX assets)
- Internal RAM: 18 KB (partial framebuffer (6K) + TouchGFX (12k))



Demo 8: Three screens



No external RAM due to partial framebuffer

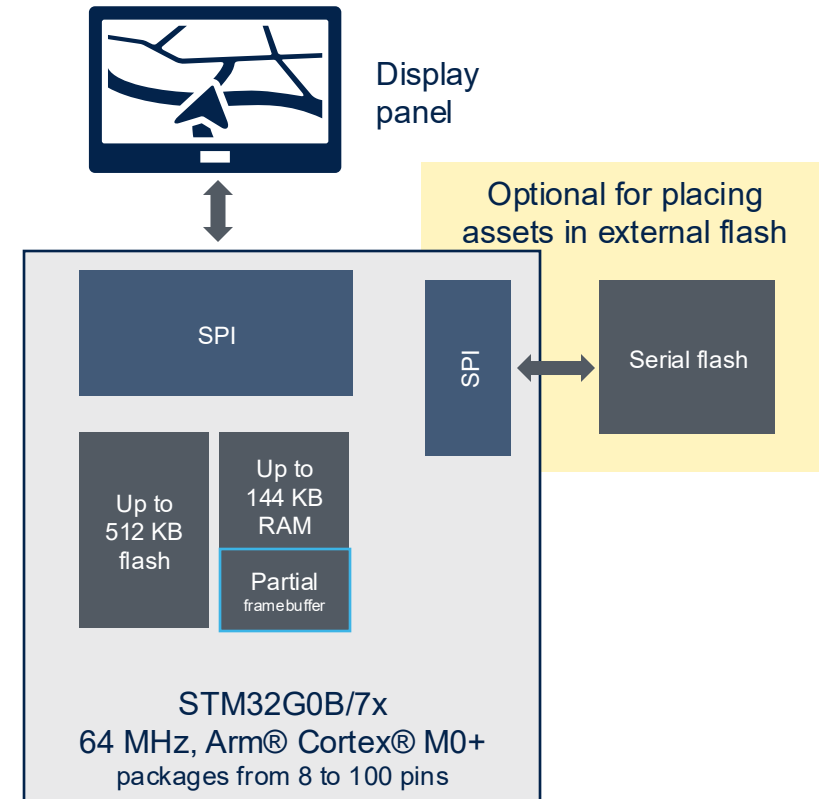


# STM32G0

## Entry-level graphics with cost-effective MCU

Displays up to 3.5" and up to 320 x 240

- **NUCLEO-G071RB + X-NUCLEO-GFX01M2**
  - 2.2" SPI QVGA 320 x 240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)



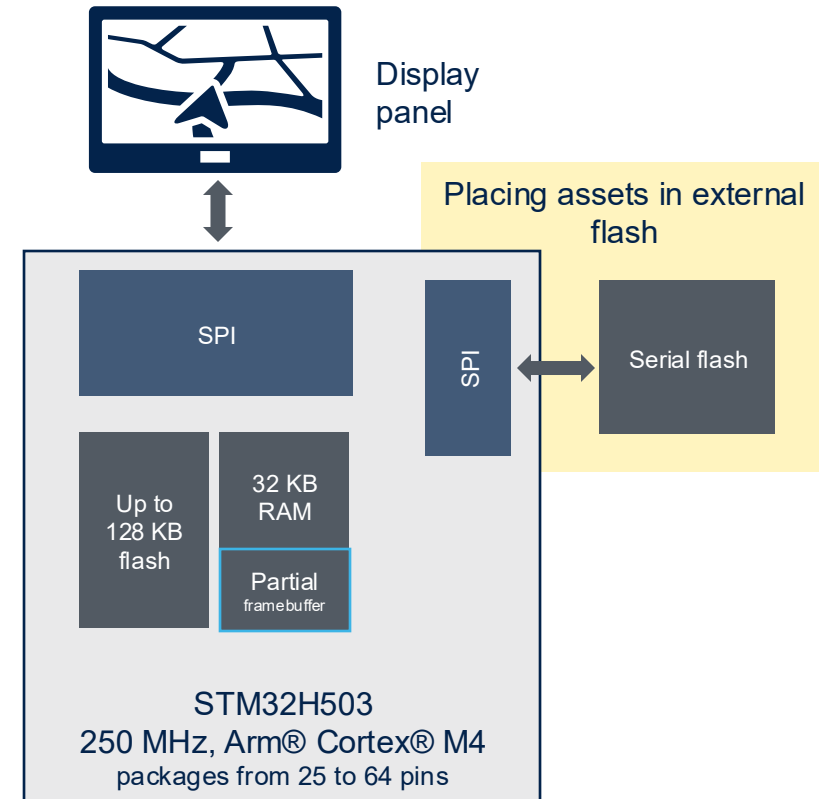
No external RAM due to partial framebuffer

# STM32H503

## Entry-level graphics with mid-range, affordable MCU

Displays up to 3.5" and up to 320 x 240

- **NUCLEO-H503RB + X-NUCLEO-GFX01M2**
  - 2.2" SPI QVGA 320 x 240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)



No external RAM due to partial framebuffer

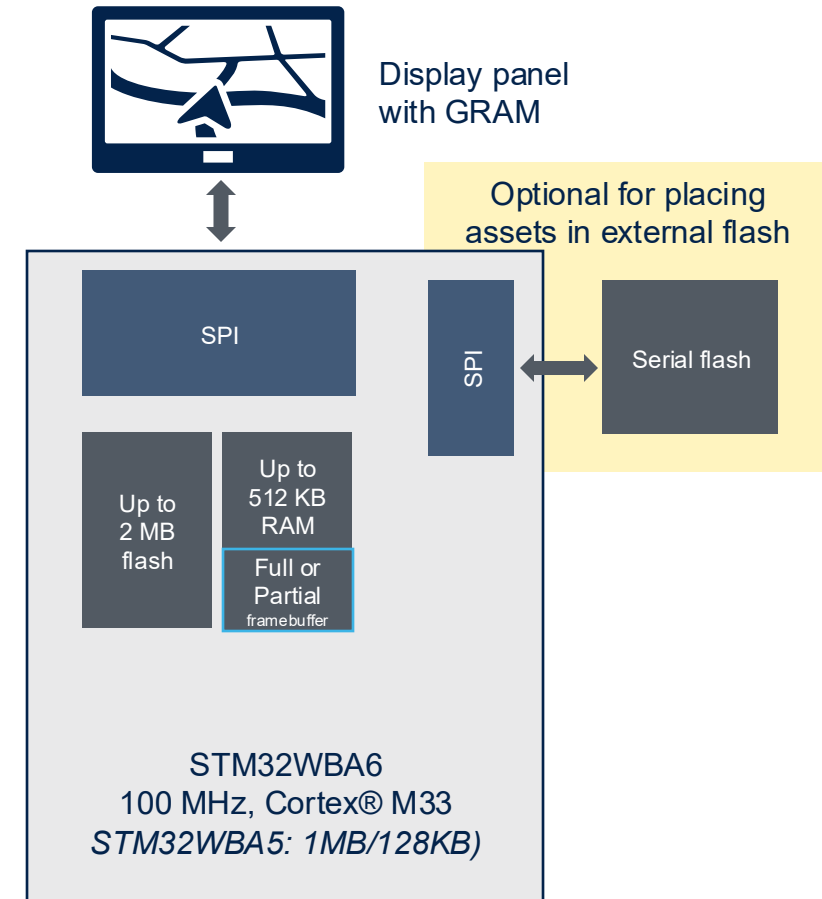


# STM32WBA

## Entry-level graphics on wireless single core MCU

Displays up to 3.5" and up to 320 x 240

- **NUCLEO-WBA65RI + RVA15MD-NUC64A** (from Riverdi)
  - 1.5" SPI 240x240 touch display
- **TouchGFXDesigner**
  - Board specific demos in full source – simple doorlock demo
  - TouchGFX board setup



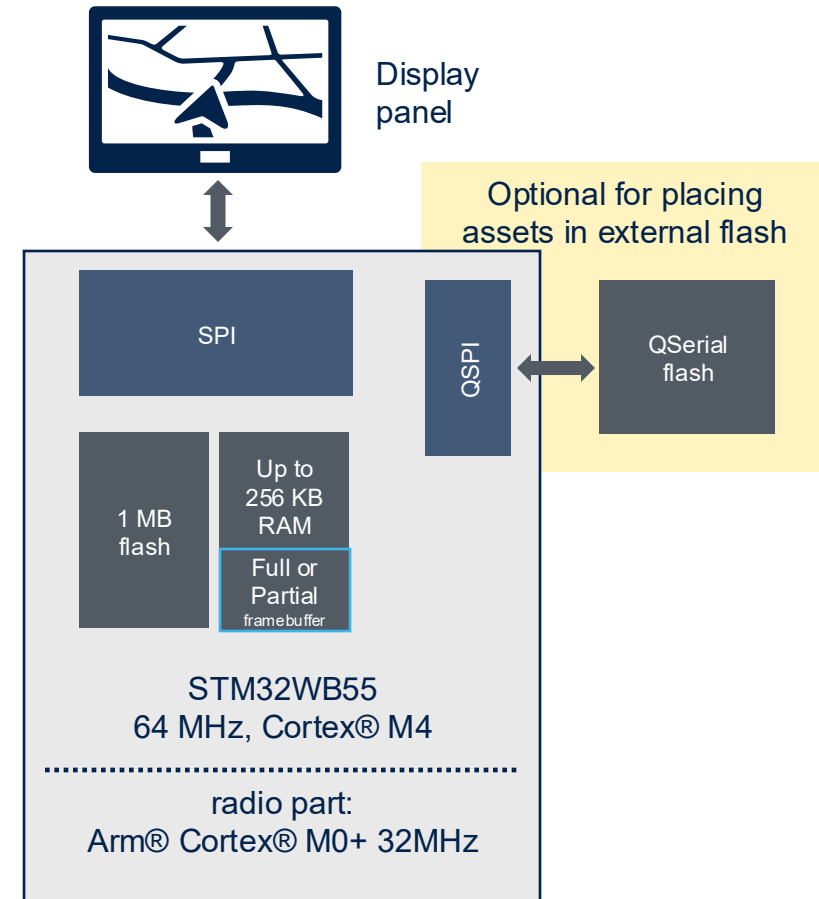
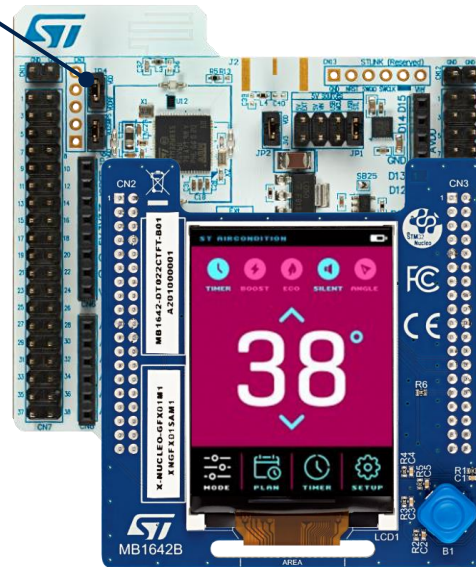
No external RAM due to partial framebuffer

# STM32WB55

## Entry-level graphics on wireless MCU

Displays up to 4.3" and up to 480 x 272

- **NUCLEO-WB55RG + X-NUCLEO-GFX01M2**
  - 2.2" SPI QVGA 320 x 240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)



No external RAM due to partial framebuffer

# On-demand webinar

## Develop cool GUIs for an improved user experience using low-cost MCUs

Develop effective GUIs using the STM32 graphics ecosystem. Discover special features targeting a 3" SPI display driven by low-cost Arm Cortex®-M0 or -M4 STM32 microcontrollers.

**You will learn how to speed up your prototyping using STM32 Nucleo kits, X-NUCLEO display boards, and ready-to-use STM32Cube expansion software.**

**Watch now**

# Our technology starts with You

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