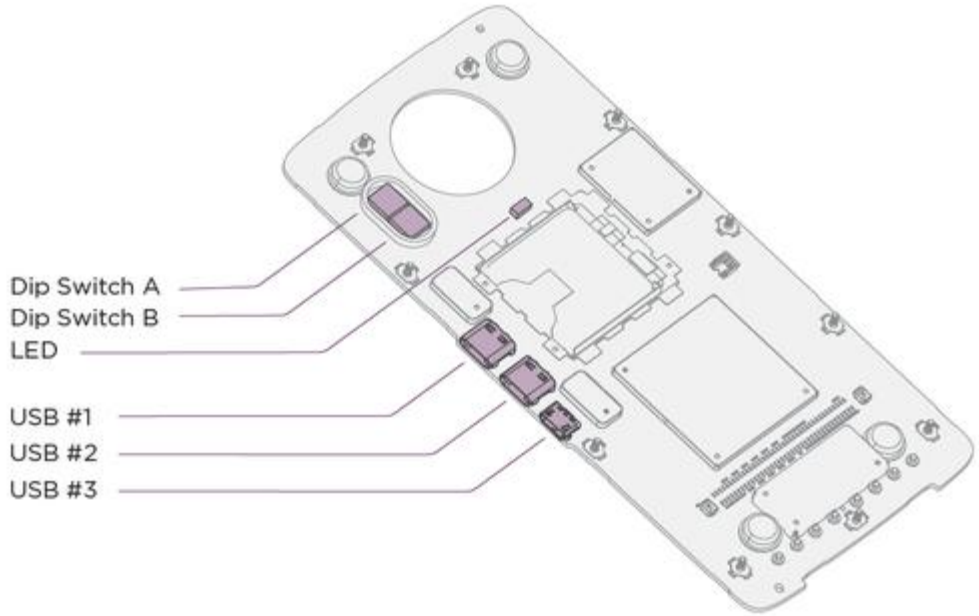
MDK User Guide: Reference Moto Mod

Part number: SJYN1622A

Overview

The Reference Moto Mod is the central component for the creation of your prototypes. It provides the core interfaces to the Moto Z platform, processing resources, GPIO and standard peripheral interfaces, power and charging control, and the capability to configure these blocks appropriately for your project.



Key Components and Configuration

The Moto Mod Micro Controller (MuC)

The MuC is the target for custom firmware for your Moto Mod. Powered by a Cortex-M4 based STML476, it provides onboard compute and control, GPIO, and various standard interfaces used to realize your project. The MuC is the main point of communication between the Moto Z and includes Greybus abstraction layer.

Moto High Speed Bridge (Moto Bridge)

Industry standard CSI and DSI interfaces are supplied through the Moto Bridge as well as I2S audio for those Moto Mods requiring the camera or display interfaces.

Power and charging block

Contains the control, regulated and unregulated power control, battery selection, and charging paths for the Moto Mod system. See the DIP Switch B configuration section for the configuration options for this block.

USB Connectors

This set of three connectors enable connection of USB 2.0, MyDP and USB 3.1 peripherals, as well as Reference Moto Mod debug interfaces. Control and configuration of these connections is managed by the DIP switches.

Debug Connector (USB #1)

This Type C Connector is the debug port for all your projects using the Reference Moto Mod. The interfaces provided are detailed below.

- Port 1 - MuC Serial Wire Debug (SWD)
- Port 2 - MHB JTAG
- Port 3 - MuC Serial Console
- Port 4 - MHB Serial Console (Rx only)

The Moto Mod will accept 500mA of current into USB Connector 1 to power the Reference Moto Mod. USB Connector 1 will not charge the onboard battery or any battery included on your custom personality card.

USB Type-C Connector (USB #2)

This Type C Connector provides access to the following Mod interfaces:

- USB 3.1 - host and slave
- USB 2.0 - host only

The onboard battery on the Reference Moto Mod can be charged via this port. The port is compliant with USB C DRP.

MyDP connector (USB #3)

This Micro B connector provides access to the following Mod interfaces:

- USB 2.0 - host only
- MyDP

The Reference Moto Mod provides DC power out of the MyDP connector for USB Host mode support.

DIP Switch Configuration

Two DIP switches are provided to configure the Reference Moto Mod to support your Moto Mod project development.

DIP Switch A:

- These switches control routing and selection of High Speed Signal Groups A and B.
- Group A signals are defined as USB 2.0 and MyDP and are controlled by switches A3 and A4.
- Group B signals include M-PHY, USB 3.1 and I2S functionality and are controlled by switches A1 and A2.

A1/A2 High speed Group B Control:

Device Type	A1	A2	Description
Group B Disabled	Off	Off	All Group B signal paths disabled.
MHB Device	On	Off	Enables the Moto High-speed Bridge (MHB). Use this mode for devices requiring CSI or DSI on the 80-pin connector. When configured in this mode, I2S signals on the 80 pin connector are routed to the MHB as well. Used in the Display Personality Card example.
I2S Audio Device	Off	On	Use for devices requiring direct access to I2S from the Moto Z. MHB is disabled and I2S signals on the 80-pin connector are routed to the Moto Mod connection to the Moto Z. Used in the Audio Personality Card example.
USB3.1 Device	On	On	Use for devices requiring a USB3.1 host or client connection. MHB is disabled and USB3.1 is available on USB Type-C Connector.

A3/A4 High speed Group A Control:

Device Type	A3	A4	Description
Group A Disabled	Off	Off	All Group A signal paths disabled.
MyDP Device	On	Off	Group A connected to MyDP Connector. Use to connect a MyDP device to the MyDP connector. This mode can also support USB Client devices connected to the MyDP port. In this mode power is available from the Reverence Moto Mod on the VBUS pin.
USB 2.0 Client	Off	On	Group A connected to USB Type-C connector. Use to connect a USB Client device on the USB Type-C connector.
USB2.0 Personality Card	On	On	Group A signals are routed to the 80-pin connector.

Dip Switch B:

These switches enable the reference clock for the Personality Card, control various power and charging configurations, and select GPIO or I2S functionality to the I2S signal group of the 80-pin connector.

Switch B1 - Personality Card Reference Clock Control:

Device Type	B1	Description
Personality Card with onboard reference clock or none required	Off	19.2 MHz clock disabled, pin 36 of 80-pin connector is high impedance
Personality Card requiring 19.2 MHz reference clock	On	19.2 MHz clock enabled, present at pin 36 of 80-pin connector

Switch B2 - I2S Signal Group Alternate Mode:

Device Type	B2	Description
I2S on 80-pin connector	Off	Use this mode if using I2S from the MHB
GPIO alternate mode	On	Use this mode to use the I2S signals as GPIO from the MuC (Notes 1,2)

Note 1: This mode disables the external 32kHz clock of the MuC.
Note 2: This mode disables the State of Charge LED functionality. (See On Board LEDs below).

Switch B3 - Battery Selection:

Device Type	B3	Description
Reference Mod Battery	Off	Use this configuration if your project uses the battery provided on the Reference Moto Mod. In this mode, pin 17 of the 80-pin connector is disabled from providing power to the system.
Personality card Battery	On	Use this configuration if your personality card includes a battery. Charging and Metering is the responsibility of the Personality Card. In this mode, battery power for the Reference Moto Mod is derived from the 80-pin connector pin 17.

Switch B4 - USB-C Power Source:

Device Type	B4	Description
USB Connector 2 Powered	Off	Use this mode to power the Reference Moto Mod from USB Type-C. Charging of onboard or personality Card battery is available (See Switch B3 above).
Debug connector Powered	On	Use this mode to power the Reference Moto Mod from the Debug Connector Note: This mode will not charge any battery (on-board or Personality Card)

Example Personality Card Configurations

The table below details the DIP switch configuration for each of the available example Personality Cards.

Example Personality Card Configurations:

Personality Card	DIP Switch A				DIP Switch B			
	A1	A2	A3	A4	B1	B2	B3	B4
Display	On	Off	X	X	X	X	X	X
Audio	Off	On	X	X	X	X	X	X
Battery	X	X	X	X	X	X	On	X
Temperature	On	Off	X	X	X	X	X	X

Note: X = Not Applicable

Onboard LEDs

The Reference Moto Mod contains three LEDs. Two LEDs are used to indicate the Reference Moto Mod battery state of charge, and the other is available for you to use in your applications.

LED Connection and Active State:

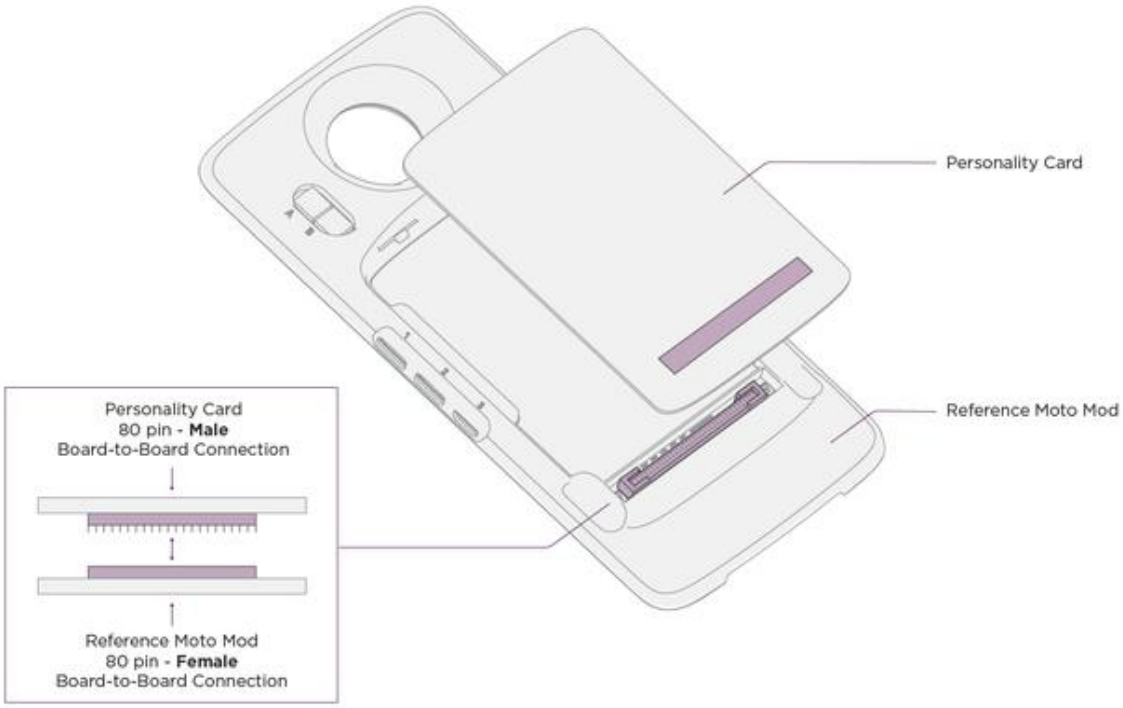
LED	GPIO	State	Usage
Red LED (Bottom)	PD7	Low: LED On High: LED off	Indicates Battery State of Charge (SoC) in conjunction with the Green LED
Green LED (Bottom)	PE7	Low: LED On High: LED off	Indicates Battery SoC in conjunction with the Red LED
White LED (Top)	PE8	Low: LED On High: LED off	User defined

Personality Board Connector

Personality cards attach to the 80-pin connector. This connector provides access to GPIO, power, and multiple standard busses. The function of some pins is controlled by the DIP switches.

Connector Definition

The 80-pin connector exposes various Moto Mod interfaces to make it easy for you to develop and switch between projects using a single Reference Moto Mod.



Key	Pin	Signal Name	Signal Type	Primary Function
DC Power source	1	3PC	Power	Regulated 3.3-volt, 500mA power source (see note 1)
Ground	2	PC1	MuC GPIO	Primary I2C data (see note 2)
Analog input/GPIO	3	HSIC_STB	MHB HSIC	HSIC Strobe. For details, see USB-Ext firmware document
Display Tearing Effect	4	PC0	MuC GPIO	Primary I2C clock (see note 2)
Interrupt input/GPIO	5	HSIC_DAT	MHB HSIC	HSIC data. For details, see USB-Ext firmware document
	6	PB2	MuC GPIO	General-purpose timer/clock output
	7	GND	Ground	System ground
	8	PA2	MuC GPIO	MuC UART TX (output to personality card)
	9	5P0	Power	Regulated 5-volt, 1.5A power source (see note 1)
	10	PA3	MuC GPIO	MuC UART RX (input from personality card)
	11	VBUS	Power	VBUS power input from Moto Mod
	12	PA0	MuC GPIO	MuC UART Clear-to-send (input from personality card)
	13	1P8	Power	Regulated 1.8-volt, 1A power source (see note 1)
	14	PA1	MuC GPIO	MuC UART Ready-to-send (output to personality card)
	15	GND	Ground	System ground
	16	PA10	MuC GPIO	User-defined GPIO; wakeable interrupt input
	17	VSYS	Power	System DC power from Personality Card
	18	PC8	MuC GPIO	User-defined GPIO; do not use as interrupt input
	19	B+	Power	System DC power from Moto Mod
	20	PA7	MuC GPIO	SPI master out/slave in (output to personality card)

Key	Pin	Signal Name	Signal Type	Primary Function
	21	GND	Ground	System ground
	22	PA6	MuC GPIO	SPI master in/slave out (input from personality card)
	23	PC7	MuC GPIO	User-defined GPIO; wakeable interrupt input
	24	PD6	MuC GPIO	User-defined GPIO; wakeable interrupt input
	25	IO_16	I2S	I2S bit clock from Moto Z to personality card (see note 3)
	26	PA5	MuC GPIO	SPI master clock (output to personality card)
	27	IO_17	I2S	I2S word clock from Moto Z to personality card (see note 3)
	28	PA4	MuC GPIO	Active low SPI master chip select 0 (output to personality card)
	29	IO_20	I2S	I2S data to Moto Z from personality card (see note 3)
	30	PA15	MuC GPIO	Active low SPI master chip select 1 (output to personality card)
	31	IO_19	I2S	I2S data to personality card from Moto Z (see note 3)
	32	PA9	MuC GPIO	User-defined GPIO; do not use as interrupt input
	33	PC9	MuC GPIO	User-defined GPIO; do not use as interrupt input
	34	GND	Ground	System ground
	35	TE	GPIO	Tearing effect GPIO output to personality card
	36	19.2MHZ CLK	Clock	19.2 MHz CMOS clock output to personality card (see note 4)
	37	GND	Ground	System ground
	38	GND	Ground	System ground
	39	DSI_D0-	Display	Display data lane 0 negative output to personality

Key	Pin	Signal Name	Signal Type	Primary Function
				card
	40	DSI_D2-	Display	Display data lane 2 negative output to personality card
	41	DSI_D0+	Display	Display data lane 0 positive output to personality card
	42	DSI_D2+	Display	Display data lane 2 positive output to personality card
	43	GND	Ground	System ground
	44	GND	Ground	System ground
	45	DSI_D1-	Display	Display data lane 1 negative output to personality card
	46	DSI_D3-	Display	Display data lane 3 negative output to personality card
	47	DSI_D1+	Display	Display data lane 1 positive output to personality card
	48	DSI_D3+	Display	Display data lane 3 positive output to personality card
	49	GND	Ground	System ground
	50	GND	Ground	System ground
	51	DSI_CLK-	Display	Display clock negative output to personality card
	52	MUC_PB11	MuC GPIO	Secondary I2C data (see note 2)
	53	DSI_CLK+	Display	Display clock positive output to personality card
	54	PB10	MuC GPIO	Secondary I2C clock (see note 2)
	55	GND	Ground	System ground
	56	GND	Ground	System ground
	57	CSI_D0-	Camera	Camera data lane 0 negative input from personality card

Key	Pin	Signal Name	Signal Type	Primary Function
	58	CSI_D2-	Camera	Camera data lane 2 negative input from personality card
	59	CSI_D0+	Camera	Camera data lane 0 positive input from personality card
	60	CSI_D2+	Camera	Camera data lane 2 positive input from personality card
	61	GND	Ground	System ground
	62	GND	Ground	System ground
	63	CSI_D1-	Camera	Camera data lane 1 negative input from personality card
	64	CSI_D3-	Camera	Camera data lane 3 negative input from personality card
	65	CSI_D1+	Camera	Camera data lane 1 positive input from personality card
	66	CSI_D3+	Camera	Camera data lane 3 positive input from personality card
	67	GND	Ground	System ground
	68	GND	Ground	System ground
	69	CSI_CLK-	Camera	Camera clock negative input from personality card
	70	MUC_PH0	MuC GPIO	User-defined GPIO; do not use as interrupt input
	71	CSI_CLK+	Camera	Camera clock positive input from personality card
	72	PC3 (AIN)	MuC GPIO	User-defined GPIO; can be used as analog input
	73	GND	Ground	System ground
	74	PC12	MuC GPIO	User-defined GPIO; wakeable interrupt input
	75	USB+	USB	USB data positive (see note 5)
	76	PG9	MuC GPIO	User-defined GPIO; wakeable interrupt input
	77	USB-	USB	USB data negative (see note 5)

Key	Pin	Signal Name	Signal Type	Primary Function
	78	PG10	MuC GPIO	User-defined GPIO; wakeable interrupt input
	79	GND	Ground	System ground
	80	PG12	MuC GPIO	User-defined GPIO; wakeable interrupt input

Notes:

- (1) Regulator current limit assumes source selected by DIP Switch B3 provides sufficient DC power for your application.
- (2) All MuC GPIO referenced to 1.8V.
- (3) I2S present only if DIP switches A1 and A2 set to enable I2S audio device type.
- (4) 19.2 MHz clock present DIP switch B1 set to “on” position.
- (5) USB signals present only if DIP switches A3 and A4 set to direct these signals to the personality card.

Using Example Personality Cards

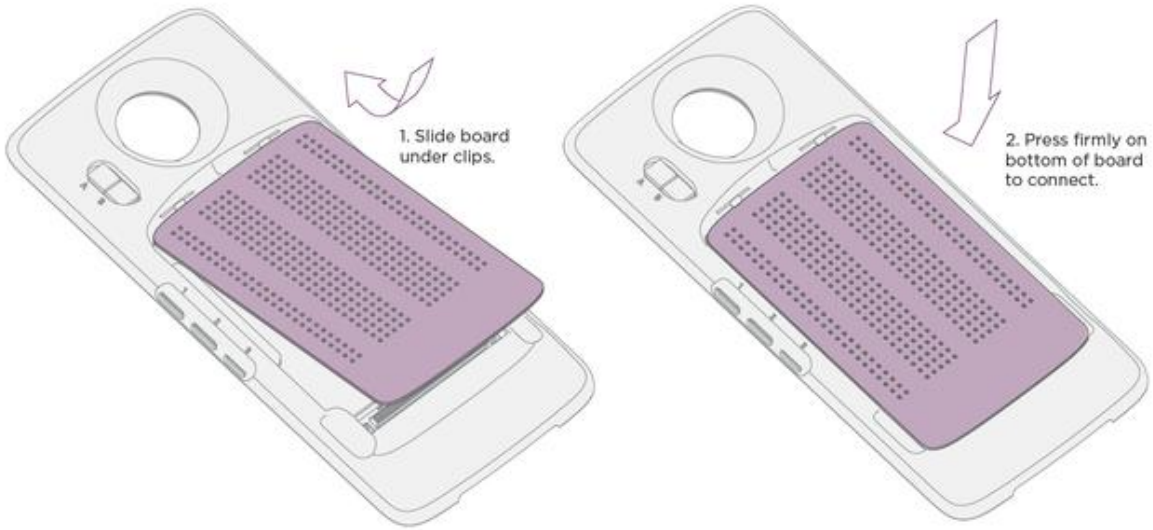
Inserting and Removing Personality Card

NOTE:

ALWAYS detach the Reference Moto Mod from Moto Z before attempting to insert or remove a Personality Card, the Perforated Board, or Raspberry Pi HAT Adapter Board.

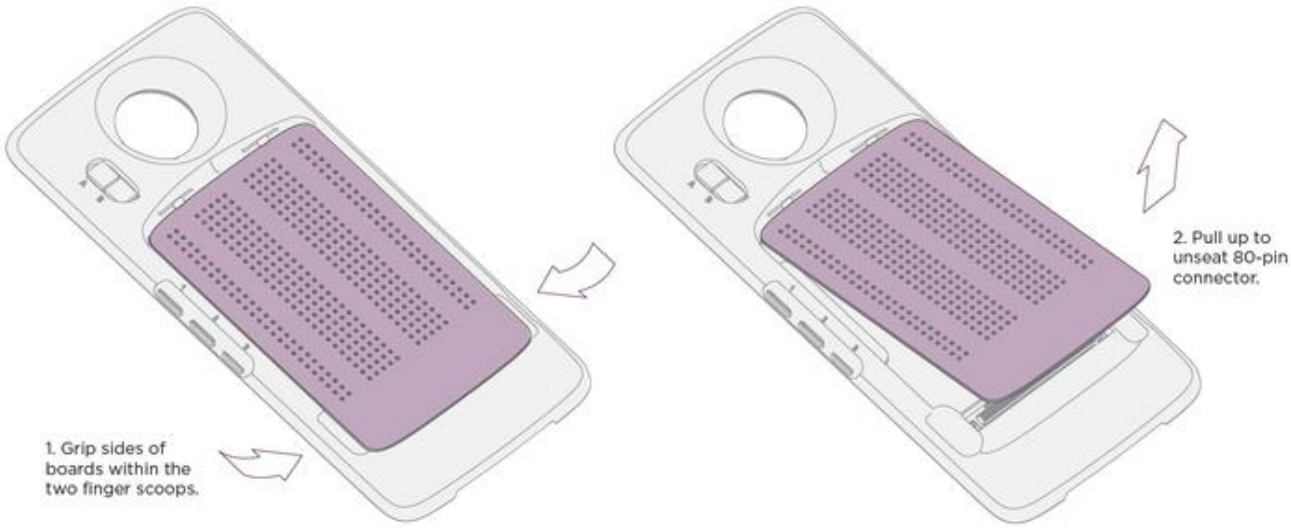
Inserting Personality Card Into Reference Moto Mod

- Step 1: Toe-in top edge of board under housing tabs
- Step 2: Press board down to seat the connector



Removing Personality Card From Reference Moto Mod

- Step 1: Grip sides of board within two finger scoops
- Step 2: Pull up to unseat the 80-pin connector



Installation of Custom Firmware

The example Personality Cards require custom firmware on the Reference Moto Mod to run. Each Personality Card includes an onboard EEPROM queried by the MuC bootloader on attach. If needed, the MuC bootloader will request the Moto Z to download and install the latest firmware needed for the attached personality card.

IMPORTANT:
When using the Perforated Board, or Pi HAT Adapter Board, don't forget to create a custom bootloader for your MuC that includes your unique VID/PID, or the prototype VID 0x42. If you don't you'll end up overwriting your custom firmware with the default MuC firmware each time you boot!

Safety Instructions

Warnings

- The reference Moto Mod shall only be powered by connecting it to a Moto Z device or through the USB Connectors 1 & 2.
- A Personality Card shall only be powered by inserting it into the Reference Moto Mod.
- Always detach the Reference Moto Mod from Moto Z before attempting to insert or remove a Personality Card, the Perforated Board, or Raspberry Pi HAT Adapter Board.
- This product should be operated in a well ventilated environment.

- This product should be placed on a stable, flat, non-conductive surface in use and should not be contacted by conductive items.
- The connection of incompatible devices to the GPIO connector may affect compliance or result in damage to the unit and invalidate the connected Moto Z's warranty
- All peripherals used with the Moto Mods Development Kit should comply with relevant standards for the country of use and be marked accordingly to ensure that safety and performance requirements are met.
- If peripherals are connected via a cable or connector, the cable or connector used must offer adequate insulation and operation in order that the requirements of the relevant performance and safety requirements are met.
- Any damage to your Moto Z's caused by the use of the Moto Mods Development kit is not covered by the Moto Z limited warranty.
- Motorola accepts no liability arising from the use or misuse of the MDK or Moto Mods platform, or any applications based upon it
- Apps and MDK projects must only be built by someone competent to do so.

Instructions for safe use

To avoid malfunction or damage to your MDK or Moto Z please observe the following:

- Always use industry standard practices for handling and developing electronic devices.
- Do not expose it to water, moisture or place on a conductive surface whilst in operation.
- Do not expose it to heat from any source; the MDK is designed for reliable operation at normal ambient room temperatures.
- Take care whilst handling to avoid mechanical or electrical damage to the printed circuit board and connectors.
- Avoid handling the printed circuit board while it is powered. Only handle by the edges to minimise the risk of electrostatic discharge damage.
- Where a protective cover is provided, it is recommended that it is used to provide mechanical and electrical protection to the components.
- Take care of sharp edges and connector pins.