DMX Click - User Manual

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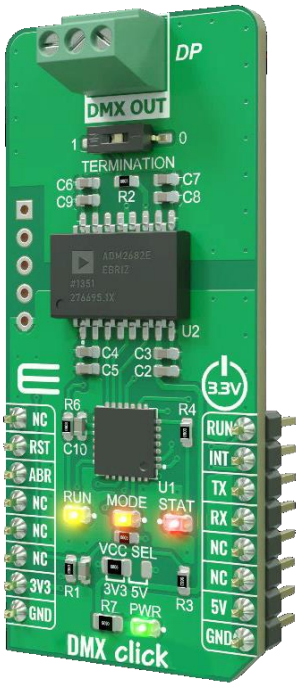
Introduction



The scope of this manual

This user guide assumes that readers have a basic knowledge of the DMX512-A communication protocol. The data frame structure and other specifics of the DMX512 protocol will not be discussed in this manual. Before working with the DMX Click, it is strongly recommended that you familiarize yourself with the DMX512-A standard.

What is DMX Click?

DMX Click is designed to accept the UART data stream on the RX pin and packs it into DMX frames, generated at the DMX output (3-pole screw terminal). Since the DMX 512-A protocol (DMX in the following text) is most commonly used to control stage lighting and other stage equipment (e.g. fog machines), it is implemented on the top of the RS485 physical layer which has a very good immunity to electromagnetic interference (EMI), which is typical in a noisy stage environment. The Click board™ also provides galvanic isolation between the DMX bus and the host application, with no additional components required.

Operating Modes

The Click board™ can be operated both as DMX MASTER and DMX SLAVE. When operated as a MASTER, it can be used to control other SLAVE devices on the bus. It is capable of controlling a single DMX 512 universe (512 channels). Note that there can be only a single MASTER device per DMX bus.

Each of the two MASTER and SLAVE operating modes has two sub-modes. The Click board™ can be actively relaying incoming UART data to the DMX bus (RUN mode) or it can be waiting for the configuration commands (CFG mode). More information about the operating modes and sub-modes can be found in the *Configuring the Click board™* section in this manual. For now, it is enough to say that the data at the RX input is interpreted differently depending on the currently selected sub-mode. Also, unlike MASTER and SLAVE operating modes that can be set only once per reset cycle, these sub-modes can be freely selected during normal operation.

UART interface

The Click board™ uses the standard UART interface to exchange data with the host controller. Default UART parameters are 115200, (8) data bits, (N)o parity, (1) stop bit. However, the Click board™ features an automatic baud rate configuration and can use a wide range of different baud rates. More about selecting a custom baud rate can be found in the respective chapter.

Other considerations

The digital signal might deteriorate with a large number of SLAVE devices connected. However, DMX Click offers a lot of freedom and flexibility. The support for multiple DMX universes can be implemented within the lighting control application itself, while the actual number of connected SLAVE devices can be increased by using two or more DMX Clicks and using them to build so-called DMX Splitters and DMX Repeaters. These devices can also be purchased separately, in specialized stage lighting stores.

A DMX network employs a daisy-chain connection topology. The last SLAVE device in the signal chain should always have its termination resistor enabled in order to allow a proper impedance matching. DMX Click offers a small dip-switch labeled as "TERMINATION" which enables the 120Ω termination resistor, when set to position "1".

Configuring the Click board™

How to reset the Click board™

It is always a good idea to reset the Click board™ before it is used. To perform reset, the RST pin of the mikroBUS™ should be pulsed LOW. After the Click board™ boots up, it is possible to select the new UART baud rate and operating mode. The end of the boot sequence is signalized by a short pulse on the INT pin and a response message over the TX pin, reporting the operating mode status (MASTER/SLAVE).

Automatic baud rate (ABR) configuration

If during the boot sequence the ABR pin is set to a HIGH logic level, the Click board™ will use the default UART settings, as described above (115200, 8, N, 1). However, if during the boot sequence the ABR pin is set to a LOW logic level, the STAT LED will start blinking while the INT pin will be held to a HIGH logic level. The Click board™ expects the value of 0x55 (character "U") to be received over the UART interface (RX pin) at the desired baud rate. Once the character has been received, the Click board™ will lock the detected baud rate and the INT pin returns to its idle state (LOW). The baud rate remains locked until the next power or reset cycle.

Note: The Click board™ will attempt to detect the baud rate of any value sent via the RX pin. Sending values other than 0x55 will cause the baud rate to be detected incorrectly.

MASTER/SLAVE selection

After reset, the Click board™ will check the logic state of the RUN pin (PWM pin of the mikroBUS™). The logic state on this pin determines whether the Click board™ boots up in MASTER or in SLAVE operating mode. Once set, the main operating mode can't be changed until the next reset cycle. After the Click board™ completes the boot sequence, the RUN pin becomes free to be used for RUN/CFG sub-mode selection. The end of the boot sequence is signalized by the INT pin and a UART response message over the TX pin.

- If the RUN pin is at a LOW logic level after the reset, the Click board™ will run as a DMX SLAVE. The MODE LED indicator will be turned OFF. The response message is: "SLAVE RDY" (terminated by the <cr><lf> sequence)
- If the RUN pin is at a HIGH logic level after the reset, the Click board™ will run as a DMX MASTER. The MODE LED indicator will be turned ON. The response message is: "MASTER RDY" (terminated by the <cr><lf> sequence)

Note: After the reset cycle, the Click board™ will first check the state of the ABR pin and then the state of the RUN pin. The best practice is to first set the ABR and RUN pins to required states and then perform reset. By monitoring the INT pin, it is possible to determine the status of the device during boot.

(MASTER) RUN mode

A rising edge on the RUN pin will cause the Click board™ to enter the RUN mode. The RUN pin is pulled up by an internal resistor.

While operating in MASTER/RUN mode, the Click board™ relays data from the RX pin to the DMX bus, by generating DMX frames. The UART input buffer length is of a (configurable) fixed size.

NOTE: No <cr> or <lf> control characters should be used to terminate the input. The parser will treat them as regular values, causing a misalignment of the input buffer. Any buffer misalignment can be resolved with a short LOW pulse on the RUN pin (while in RUN sub-mode).

The logic state of the RUN LED indicator will be inverted after each DMX frame, causing the LED to blink during normal operation.

Once enough bytes have been received to fill the input buffer, it will be swapped with the output buffer and an interrupt will signal that the input buffer is ready to receive a new data stream. However, the input buffer will not be swapped with the output buffer until it is completely filled, so the output buffer will continuously cycle the most recently received data. This may sound wrong for a typical data transfer situation, but in stage lighting situations, this is actually the perfect solution that helps to avoid unwanted blackouts when there is no data at the input.

NOTE: The interrupt signal is synchronized with the DMX Frame Break event. Even if the input buffer is full, the interrupt won't be triggered before the next Frame Break event. This helps to avoid filling the input buffer multiple times in cases where it can be filled much faster than the output frame can be transmitted (e.g., a small input buffer at 115200 bps will be completely filled long before the entire DMX universe can be transmitted to the DMX bus at 250000 bps)

(SLAVE) RUN mode

A rising edge on the RUN pin will cause the Click board™ to enter RUN mode. The RUN pin is pulled up by an internal resistor.

While operating in SLAVE/RUN mode, the Click board™ continuously receives DMX frames and decodes them into a UART data string. The data string is available at the TX pin of the Click board™. Each DMX Frame Break event that marks the beginning of a new DMX frame is signalized by an interrupt, which can be used for synchronization with the host application.

The logic state of the RUN LED indicator will be inverted after each successfully received DMX frame, causing the LED to blink during normal operation.

(MASTER/SLAVE) CFG mode

A falling edge on the RUN pin will cause the Click board™ to enter CFG mode. The RUN pin is pulled up by an internal resistor.

While in the CFG sub-mode, the Click board™ stops its current operation, expecting a configuration command string. The parsing method is the same as in the RUN sub-mode. However, the input buffer length is fixed to 9 bytes while in CFG mode. Therefore, each command must be exactly 9 bytes long. After the ninth byte has been successfully received, the received command will be parsed. There are several different configuration commands available that will be covered in the *Configuration commands* section in this manual.

The RUN LED indicator will be turned OFF while in the CFG sub-mode.

After the received command has been successfully parsed (and/or executed), the Click board™ will trigger an interrupt. Also, a UART string will be transmitted over the TX pin, containing the received command, along with the status message:

- If the command was recognized, the Click board™ will respond with the "OK" message (terminated by the <cr><lf> sequence).
- If the command was not recognized, the Click board™ will respond with the "ERR" message (terminated by the <cr><lf> sequence) and the STAT LED will remain lit until a valid command is received or until the sub-mode is changed.

NOTE: All commands are case-sensitive and no <cr> or <lf> control characters should be used when sending a command. The parser will treat them as regular values, causing a misalignment of the input buffer. Any buffer misalignment can be resolved with a short HIGH pulse on the RUN pin (while in CFG sub-mode).

DMX Start Code

The DMX Start Code must always be transmitted in any DMX-compliant system. It will be transmitted automatically (MASTER mode) and it will be automatically inserted at the beginning of the received string (SLAVE mode). DMX Click is developed with lighting applications in mind and in this case, the Start Code should be always equal to 0 (Null Start Code, NSC). However, the application developer is free to choose whether to use it or not. The value of the Start Code can be configured while the Click board™ is operated as MASTER. Its value is 0 by default.

Configuration commands

Commands structure

The Click board™ offers a set of different commands over the UART interface. The command strings typically start with the "@" character, a four-letter command mnemonic, a comma, and a three-digit command parameter. The command parameter must be entered along with the leading zeroes (e.g. "003", "221", "015"). The entire command string must always be of a fixed size (9 bytes), with no control characters added, as mentioned before.

If the command is not recognized, or if its parameter is outside the allowed range, an error condition will be signaled, as explained in the *(MASTER/SLAVE) CFG mode* section. Special commands starting with the "!" sign, use no parameters and are executed as soon as they are parsed.

MASTER mode commands

- @FLEN,XXX
  - XXX is the length of the DMX frame. The possible valid range is from od 001 to 512.
  - Default: 512

  A full DMX frame consists of 512 channels (512 bytes) plus one additional channel for the Start Code. However, it is not mandatory to transmit the entire DMX universe (512 channels). It can be shortened to any size between 1 and 512. This way, the refresh rate can be increased.

NOTE: The actual transmitted frame length will always be FLEN + 1 because the Start Code is automatically inserted at the very beginning of the DMX frame.

- @SADR,XXX
  - XXX is the start address from which the input buffer will be mapped onto the output DMX frame. The valid range is from 001 to 512
  - Default: 001

The Click board™ allows sending UART data for only a group of channels within the DMX frame instead of the entire frame. The start address is the address from which the input buffer will be mapped onto the output DMX frame.

- @BLEN,XXX
  - XXX is the length of the input data buffer which will be mapped onto the output DMX frame. The possible valid range is from od 001 to 512
  - Default: 008

This is the length of the input buffer which will be mapped onto the output DMX frame.

NOTE: The input buffer mapping boundaries (defined by the SADR and BLEN commands) must fit within the configured DMX frame length. The parser checks that the parameters of these two commands are within the DMX frame and signals an error if mapping boundaries fall outside of the DMX frame length.

- @FTMR,XXX
  - XXX is a time delay between two consequent frames. The possible valid range is from od 000 to 007 (20ms to 160ms)
  - Default: 001

When the DMX frame length is very short, the refresh rate may increase too much, which may result in failure to communicate with older and slower DMX equipment. This option allows an arbitrary delay interval between two consequent DMX frames, allowing successful communication with such DMX equipment.

- @ITMR,XXX
  - XXX is the duration of the interrupt pulse. The possible valid range is from od 000 to 007. (100us to 1.280ms)
  - Default: 001

The logic state of the INT pin is LOW when idle. If the interrupt is generated, the Click board™ will trigger a HIGH pulse and blink the STAT LED with the same pulse duration. The duration of the interrupt pulse can be set by using this command.

- @SCOD,XXX

- XXX is the value of the Start Code. The possible valid range is from od 000 to 512.
- Default: 000

The Start Code has to be sent at the beginning of each DMX frame. However, its value is not mapped from the input buffer, it is set by this command, instead. The configured Start Code value remains set until it's changed to some other value by this command. The Start Code can be saved to EEPROM with the !STORECFG command, allowing persistent value even after reset

- !PURGEBFR
  - Purges the internal buffers, clearing them all to value 0x00.

This command purges internal buffers, causing all DMX channels to be set to the value of 0x00. This command has no effect on the Start Code value.

- !STORECFG
  - Stores current configuration to EEPROM.

This command saves the configuration parameters to the MCU's EEPROM memory. The command uses a random memory address each time, reducing the wear effect of EEPROM. After the reset cycle, the Click board™ searches for the stored configuration. If no stored configuration is found, the default configuration values are loaded.

- !CLEARCFG
  - Clears the saved configuration from EEPROM

Once the configuration has been stored, it will be always retrieved from the EEPROM. The only way to revert to default values is to clear the stored configuration record. This command will delete the stored configuration record within the memory, allowing the default values to be loaded next time the Click board™ goes through the reset cycle.

- !DISPLCFG
  - Displays all the configuration settings over the UART interface

This is a very useful command which displays the configuration settings over the host UART interface. Besides displaying all the working parameters such as the frame length (FLEN), buffer start address (SADR), etc., it also gives information if the configuration settings were saved to the EEPROM, as well as the value of the Start Code (SCOD).

SLAVE mode commands

- @SADR,XXX
  - XXX is the first channel address within the DMX frame that will be received. The possible valid range is from od 001 to 512
  - Default: 001

The SLAVE device can be configured which channels to receive, disregarding all channels below the channel address set by the SADR command. The Start Code is always received and positioned at the beginning of the converted UART string, available at the UART TX pin (TX pin of the mikroBUS™)

- @FLEN,XXX
  - XXX is the length of the DMX frame portion that will be received. The possible valid range is from od 001 to 512

- Default: 008

The length of the DMX frame portion that will be received by the SLAVE device can be set by using this command. Channels beyond the received range will be disregarded. The possible valid range is from od 001 to 512.

NOTE: If the parameters of the SADR and FLEN commands are set to channel addresses beyond the received DMX frame length, no error condition will be signaled. In this case, the SLAVE device will keep waiting for the particular channels that are out of range.

- @ITMR,XXX
  - XXX is the duration of the interrupt pulse. The possible valid range is from od 000 to 007 (100us to 1.280ms) [1)]
  - Default: 001

- !STORECFG
  - Stores current configuration to EEPROM [1)]

- !CLEARCFG
  - Clears the saved configuration from EEPROM [1)]

- !DISPLCFG
  - Displays all the configuration settings over the UART interface [1)]

[1)] See explanation in the ***MASTER commands*** section

Appendix:

DMX Click ABR setup and mode selection flow chart