TCS3414 EVM

USER'S GUIDE ams

TCS3414 LIGHT-TO-DIGITAL COLOR LIGHT SENSOR EVALUATION SYSTEM

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INITIAL HARDWARE SETUP

The software should be installed prior to connecting any hardware to the computer. Follow the instructions found in the Quick Start Guide (QSG). This will load the required software for the graphical user interface (GUI).

The hardware consists of the Controller EVM v2.1 motherboard, the TCS3414 EVM2 evaluation daughterboard and a USB interface cable.

When the USB cable is first connected the green LED should light up indicating that power is being received via the USB interface, and the controller board processor is running. If the green LED does not light up check the USB cable connections unplug the USB cable and try again. If after re-try no green LED check the PC for USB error messages. See resources section at end of this document for additional assistance.

ESTABLISHING BASIC FUNCTIONALITY

The software should be started using the desktop icon "DigitalLightSensor" or by double clicking the "DigitalLightSensor.exe" file from the installation directory. The default installation directory path is:

C:\Program Files\ams\TCS3414_EVM2   Windows 32 bit operating systems
C:\Program Files (x86)\ams\TCS3414_EVM2   Windows 64 bit operating systems

A different install path may be selected by the user. When started, the following windows will open on the PC. The bottom window is the main user interface "child window" and should be positioned on the screen for easy access. The top window "parent window" is not typically needed and may be placed out of the way. This window is the parent window (PW) to the child window (CW) and may be used to reset the CW.

Clicking on the red "X" on the PW will close both PW and CW. Clicking on the red "X" on the CW will close only the CW.

The "Functional" tabs on both the left and right side of the CW will be selected by default each time the application software is opened. On the right side numbers should be changing showing that the Ambient Light Sensing (ALS) function is operational. By changing the ambient light source or waving your hand over the sensor at ~4 inch (100mm) separation you should see the ALS readings change correspondingly with light level reaching the sensor.
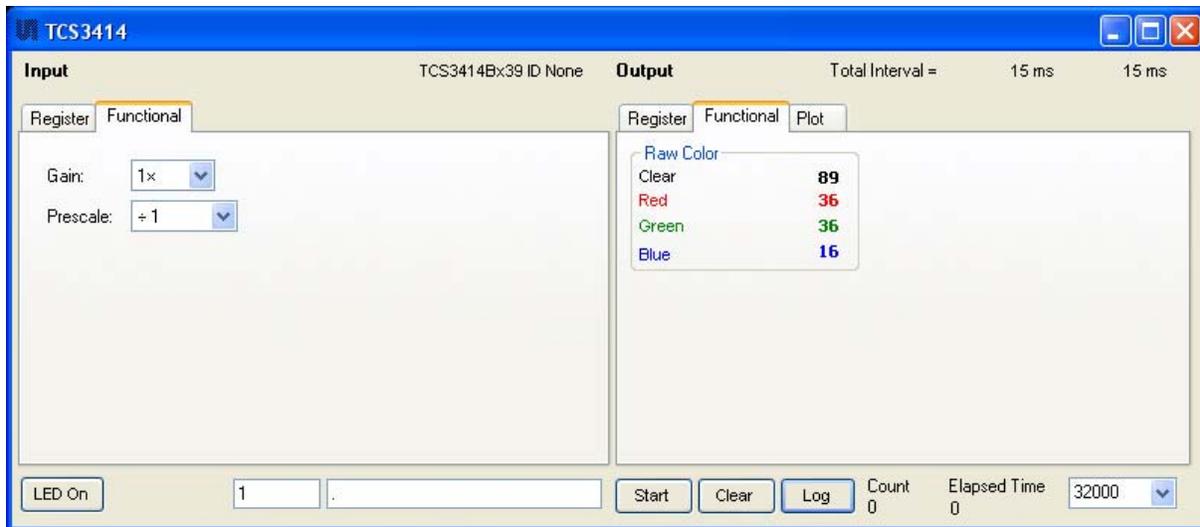
The balance of this document identifies and describes the controls available on the different tabs of the GUI. In combination with the TCS3414 datasheet, the quick start guide (QSG) and application notes available on the ams website www.ams.com there should be enough information to allow thorough evaluation of the TCS3414 device.

# TCS3414 EVM2 GRAPHICAL USER INTERFACE (GUI)

SOFTWARE OVERVIEW

On initialization the software displays two windows – a smaller "Digital Light Sensor" window and a larger window containing controls pertinent to the device connected.

If "No Devices" appears, verify that the daughterboard is connected to the motherboard properly. If "No_HID" appears, verify the USB cable is connected. A green LED on the motherboard indicates that the USB cable is connected and providing power to the system.

The "Reset" button can be pressed or the software can be restarted to reinitialize the system.

The CW contains the user interface with control buttons, fields, selection boxes and output values for the identified device connected. Tabs are used to make control and evaluation of specific device functions easy. For the TCS3414 devices the initial display screen is shown:
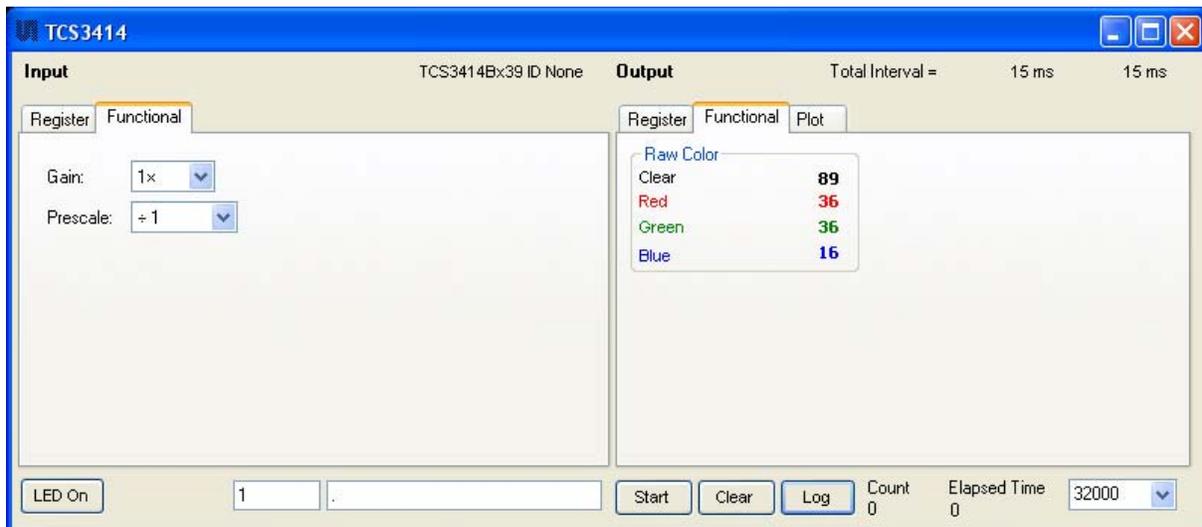
This window has inputs organized on the left, and outputs organized on the right. Values for register variables may be set using multiple techniques. The Functional tab is commonly used to quickly evaluate the device with nominal settings. The Input Register tab allows the register settings to be changed, and the Output Register tab allows registers to be viewed.

By default the "Functional" tabs have the focus. The values shown in this document will not exactly match a users system but the basic window and controls should be identical. This document will identify the usage and operation of these items in detail.

Always visible along the bottom are the following controls:
- LED Off –Toggles the green controller board LED between the on and off states. This LED is a good power-on indicator but can introduce errors in the optical tests. However it is recommended, for accurate measurements, to turn the LED off.
- A section containing logging controls and sampling status information:

1. Toggles LED on the controller board.
2. Text entered here is stored in the log buffer. By default, this field is filled with a new number for each "Child" window opened, but it may be changed to contain any information that you wish to place in the log.
3. Text entered here is used to create the default value of the log file name, and also stored in the log buffer. The default name contains the Part Name and address shown in the large "Child" window, an underscore ("_"), the text entered here, and then the characters "_Log.csv". The log file name can be changed from the default before the file is written. By default, this field contains only a period (".").

   Sample:

   TCS3414Bx39_1-2-3_Log.csv

   ——— From DigitalLightSensor.exe
   ——— From User Input

4. The start button tells the program to start logging. The fields entered in #2 and #3 will be stored in the output. If you change the values in #2 or #3, the corresponding field data will change in the output beginning at the time of the change. The default log file name is determined from the text values when the file is written.
5. Clear –The Clear button will flush the previous optical sample readings and reset the elapsed time indicator (see #7 and #8).
6. Log – Creates a log file with data. The data is stored as a comma-separated-value (csv) file. The filename will be assigned as explained in #3. This will cause the system to write out any data currently in the log buffer. The log button does not clear the data from the buffer. If you wish to clear the buffer after saving it, use the Clear button (see #5).
7. Count of samples in the log buffer. When that number reaches the limit selected in #9, the system will show a file dialog to save the log in a named file.
8. The elapsed time since the beginning of logging data.
9. The number of log samples to collect before log data is written to the log file. Any of the programmed values may be selected, or a different value may be entered, followed by pressing the Enter or Tab keys. A maximum of 32000 samples can be requested. If the falue being entered is invalid, this field will display a yellow background, and the previous value will be used until valid data is entered.

INPUT SIDE, "FUNCTIONAL" TAB

Simple controls exist for the gain level and prescale value settings.
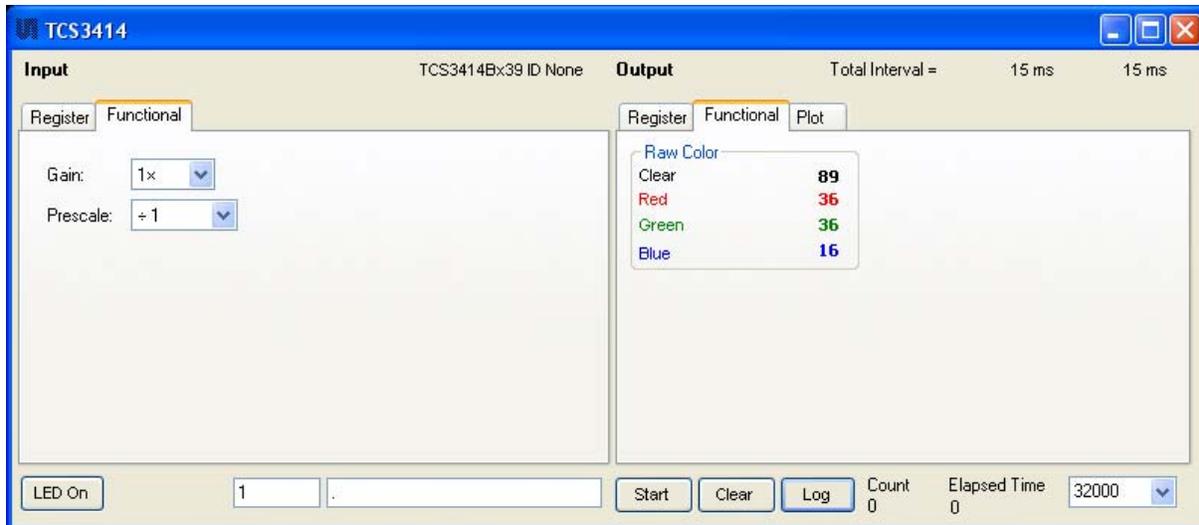
GAIN

The gain control allows the user access to the GAIN value in the Gain register (0x07). The gain amplifies the four parallel ADC signals to increase sensitivity. The gain options include 1x, 4x, 16x and 64x and are selected from the list box when the down arrow is depressed.

PRESCALE

The prescale control allows the user to control the PRESCALER value in the Gain register (0x07). The prescaler divides the 4 output counts by 1 to 64 in powers of 2. The divider values are selected from the list box when the down arrow is pressed.

> NOTE: The gain adjustment can extend the dynamic range of the light input up to a factor of 64× before analog or digital saturation occurs. If analog saturation has occurred, lowering the gain sensitivity will likely prevent analog saturation, especially when the integration time is relatively short. For longer integration times, the 16-bit output could be in digital saturation (64K). If lowering the gain to 1× does not prevent digital saturation from occurring, using the PRESCALER can be helpful.

> The most sensitive gain setting of the device would be when GAIN is set to 64×, and PRESCALER is set to divide by 1. The least sensitive setting would be a GAIN setting of 1× and PRESCALER set to divide by 64. The saturation level of the device is partially dependant on the integration time. Digital saturation occurs when the ADC output registers overflow. Digital saturation is reached at 65,535, thus the full-scale output of the TCS3414 is 65,535 (16-bits). If the part continues to be in digital saturation at the least sensitive setting, it may ne possible to lower the integration time (see the Timing register).

INPUT SIDE, "REGISTER" TAB

The Register tab provides for direct control of the registers of the device.

"Control" Sub Tab
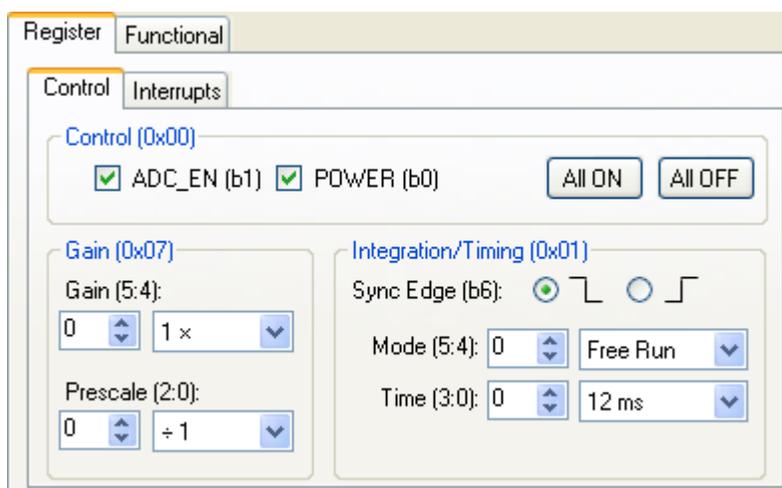
The Control sub-tab allows enabling and disabling device functionality, controlling the gain/prescale values and also controlling Integration timing and modes.

Additional buttons provide options for simultaneously turning ON all parts of the device (All On), or turning OFF all parts of the device.

For ease of use, most fields with 2 or more bits are represented by two controls; a numeric edit box with up/down arrows and a pull-down list. In each case, the numeric box represents the numeric value of the bits in the field (e.g. a 2-bit field can be 0-3). The pull-down list contains a list of the *meaning* of each of the valid values (e.g. Gain can be 1×, 2×, 4×, 64×). The contents of these controls both change the register field and when either field is changed, the other one is updated to the matching value. The numeric control may be changed by typing a new value into it, or by clicking on the up/down buttons to increment/decrement the current value. When the cursor is active in this control, you may also press the up and down arrow keys to increment or decrement the current value.

- Control register (0x00) – Provides the ON/OFF control of the device. Checkboxes are provided to allow selection of specific functions on the device. When a box is checked, the corresponding bit is set to 1; when unchecked, the bit is 0.
    1. POWER (b0) – Power on. Activates internal oscillator. When =0 device is in standby.
    2. ADC_EN (b1) – ADC Enable. Writing a one (1) enables the ALS.
    3. All ON – Turns both POWER and ADC_EN bits on using one operation.
    4. All OFF – Turns both POWER and ADC_EN bits off using one operation.
- Gain register (0x07) – Controls the gain and prescaler settings.
    1. Gain (5:4) – The GAIN field amplifies the four parallel ADC signals to increase sensitivity. Valid values are 0-3, which correspond to gains of 1×, 2×, 4×, and 64×.
    2. Prescale (2:0) – The prescaler divides the four output counts by 1 to 64 in powers of two. The valid numeric values are 0-6, which correspond to dividers of 1, 2, 4, 8, 16, 32 and 64 respectively.
- Integration/Riming register (0x01) – Controls the timing and synchronization modes.
    1. Sync Edge (b6) – These two radio buttons select whether the integration cycle ends on the falling or rising edge of the ZYNC input signal when the Sync Count mode of integration is selected. This bit is ignored in all other integration modes.
    2. Mode (5:4) – Controls the mode by which integration is triggered. Valid values are 0-3, which correspond to the Free Run, Manual On, Sync Timed, and Sync Count modes, respectively.

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- Free Run (00b) – In this mode, the integrator is free-running and one of the three internally-generated Nominal Integration Times is selected for each conversion (see Nominal Integration Time table below.
- Manual On (01b) – Manually start/stop integration through the serial bus using the ADC_EN bit in the Control Register.
- Sync Timed (10b) – Synchronize exactly one internally-timed integration cycle as specified in the Nominal Integration Time table, beginning 2.4 µs after being initiated by the SYNC IN pin.
- Synch Count (11b) – Integrate over a specified number of pulses on SYNC IN pin (see SYNC IN Pulse Count table below). Minimum width of sync pulse is 50 µs. SYNC IN must be low at least 3.6 µs.

3. Param (3:0) – This multipurpose field is used in various ways depending on the Integration Mode specified above. It is not used in the Manual On mode. In the Free Run and Sync Timed modes, it specifies the integration time for each cycle. For the Sync Count mode, it specifies the number of sync pulses to be used for each integration cycle.

NOTE: This field contains more bits or values than are defined for every mode. Writing invalid parameter values will produce undefined results.

NOTE: The integration Mode and Time/Counter (Param) fields should be written BEFORE the ADC_EN bit is asserted.

FIELD VALUE	NOMINAL INTEGRATION TIME
0000b	12 ms
0001b	100 ms
0010b	400 ms

FIELD VALUE	SYNC IN PULSE COUNT
0000b	1
0001b	2
0010b	4
0011b	8
0100b	16
0101b	32
0110b	64
0111b	128
1000b	256

"Interrupt" Sub Tab

The Interrupt sub-tab allows the user to control the Interrupt pin and the conditions which generate and interrupt, as well as control of the behavior of the interrupt signal itself.

Also on this screen is a button that will automatically generate the register values to provide threshold settings 25% higher and lower than the currently measured amount of ambient light.

- Interrupt Source register (0x03) – Selects which ADC channel value to use to generate an interrupt; Clear (11b), Red (01b), Green (00b), or Blue (10b). Only one of the four ADC channels can be selected. The Green channel is selected by default.
- Interrupt register (0x02) – Provides control over when and how interrupts are generated.
  1. Mode (5:4) – Selects the behavior of an interrupt once it is triggered.
     - Disabled (00b) – Disables all external interrupts from the device.
     - Level (01b) – The active-low interrupt signal is maintained until a Clear Interrupt command is written to the command register.
     - SMB Alert (01b) – The active-low interrupt signal is maintained until it is cleared by a successful read from the SMB Alert Response Address. This interrupt can also be cleared with the Clear Interrupt command.
     - Force (11b) – Sets a single interrupt and proceeds as in SMB Alert Mode. To force another interrupt, you must select a different Interrupt Mode and then select the Force Mode again.
  2. Persist (2:0) – Controls the rate of interrupts to the host processor by specifying how long (or if) an out-of-threshold condition must persist before an interrupt is generated.
     - Every (000b) – Every ADC cycle generates an interrupt.
     - Single (001b) – Any value, on the selected channel, outside of threshold range generates an interrupt.
     - 0.1 sec (010b) – If the selected channel remains continuously out of range for 0.1 second, an interrupt is generated.
     - 1 sec (011b) – If the selected channel remains continuously out of range for one second, an interrupt is generated.
  3. Stop on Interrupt (b6) – Stop ADC integration on interrupt. When high, ADC integration will stop once an interrupt is asserted. To resume operation (1) de-assert ADC_EN using the Control register, (2) clear interrupt using the Command register, and (3) re-assert ADC_EN using the control register.

    NOTE: Use this bit to isolate a particular condition when the sensor is continuously integrating.

4. Interrupt Low Threshold (0x08, 0x09) – Low light threshold for interrupt.
   - ILTL (0x08) – The lower 8 bits of the 16 bit low threshold value.
   - ILTH (0x09) – The upper 8 bits of the 16 bit low threshold value.
5. Interrupt High Threshold (0x0A, 0x0B) – High light threshold for interrupt.
   - IHTL (0x0A) – The lower 8 bits of the 16 bit high threshold value.
   - AIHTH (0x0B) – The upper 8 bits of the 16 bit high threshold value.
6. +/-25% – This button will calculate new low and high threshold values based on the current value of the selected channel. The new low threshold will be 25% lower than the current channel value, and the high threshold will ne 25% higher than the current channel value.

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OUTPUT SIDE, "REGISTER" TAB

The value of internal registers is displayed on this tab. Register values cannot be set here. To set registers use the Register tab on the input side of the screen.

Controls are provided for clearing the interrupt. The current interrupt status is also shown.

CDATA, RDATA, GDATA, and BDATA are the ADC values from the Clear, Red, Green and Blue channel photodiodes. Each value is read via two 8-bit registers.

- ID (0x12) – The ID register provides the value for the part number.
- Control (0x00) – Displays the internal status bits from the Control register. An interrupt active and ADC valid bits are here.
- Color Data
  1. CDATA (0x16, 0x17):
     - CDATA (0x16) – The lower 8 ADC bits of the Clear photodiode.
     - CDATAH (0x17) – The upper 8 ADC bits of the Clear photodiode.
     - The combined 16-bit value of the Clear channel is displayed in black text.
  2. RDATA (0x12, 0x13):
     - RDATA (0x12) – The lower 8 ADC bits of the Red photodiode.
     - RDATAH (0x13) – The upper 8 ADC bits of the Red photodiode.
     - The combined 16-bit value of the Red channel is displayed in red text.
  3. GDATA (0x10, 0x11):
     - GDATA (0x10) – The lower 8 ADC bits of the Green photodiode.
     - GDATAH (0x11) – The upper 8 ADC bits of the Green photodiode.
     - The combined 16-bit value of the Green channel is displayed in green text.
  4. BDATA (0x14, 0x15):
     - BDATA (0x14) – The lower 8 ADC bits of the Blue photodiode.
     - BDATAH (0x15) – The upper 8 ADC bits of the Blue photodiode.
     - The combined 16-bit value of the Blue channel is displayed in blue text.
- Clear Interrupt – Clicking on this button will clear the interrupt condition. If the current interrupt mode is Disabled, or Level, the interrupt will be cleared by writing the Clear Interrupt command. If the interrupt mode is SMB-Alert or Force, the GUI will issue a read from the SMB Alert Response Address (0x0C) and report the responding address.

OUTPUT SIDE, "FUNCTIONAL" TAB
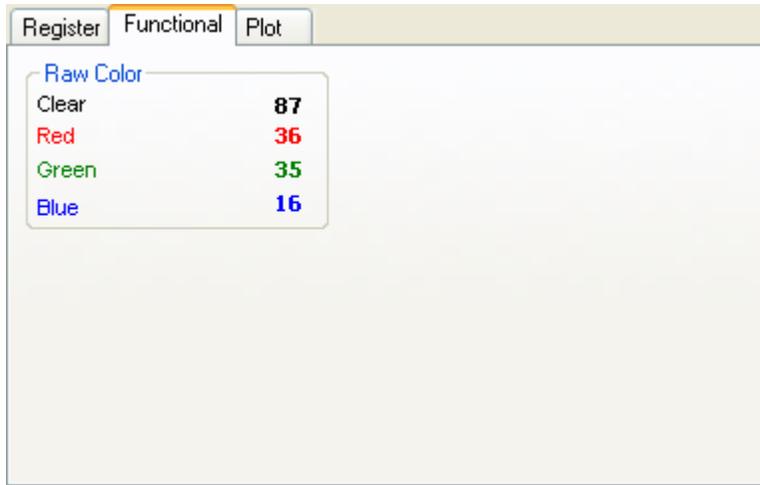
The Clear, Red, Green and Blue photodiodes output values are shown in Raw Color group.

OUTPUT SIDE, "PLOT" TAB

The Red, Green, Blue, and Clear photodiodes, can be displayed vs. time on the graph.

The graph shows all color outputs for the system. The X-axis plots 335 points then rolls over back to 0 on the graph. The Y-axis defaults to a range of 0 to 1024. The maximum Y value can be adjusted by clicking on the up and down buttons beside the range value. This maximum value may be set to any power of two starting at 64, up through 32768. The checkboxes above the graph control which values will be included on the graph.

RESOURCES

TCS3414 datasheet (included with EVM media)
Quick Start Guide (QSG included with EVM media)
Application Notes (available from website)

For additional information regarding the TCS3414, please refer to the datasheet. For information regarding the installation of the TCS3414 EVM2 host application please refer to the Quick Start Guide.

Application notes dealing with various aspects of optical measurement and optical measurement applications are available.

All content is available on the ams website http://www.ams.com

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