MOVING iMAGE TECHNOLOGIES INC

INSTRUCTIONS

FOR

INSTALLATION, OPERATION, AND MAINTENANCE

OF

IRC Series IR Emitter

Part number A000901-xxx

Document R000301, Version 2023-08-01

MOVING iMAGE TECHNOLOGIES, INC.
17760 Newhope St.
Fountain Valley, CA
Telephone: (714) 751-7998
Fax: (714) 429-7717
www.movingimagetech.com

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1. Introduction

The MiT Assisted Listening Device system is designed to meet the assistive listening, audio description, and closed captioning needs of cinemas and other venues. The system consists of an infrared (IR) emitter panel combined with other accessories such as a caption reader or headphones to receive and decode the IR data. This manual only relates to the IR emitter component, the receiving devices are described in other documents.

The use of IR simplifies receiver operation. Since IR doesn't pass through walls, the IR signal is confined to the auditorium with the IR emitter, users do not have to select a channel corresponding to the auditorium as is required for radio-linked systems, and there's no way a user in a theater can accidentally receive data for the wrong movie.

Two channels of audio as well as closed captioning are transmitted over the IR signal. The IR emitter panel is usually purchased in a kit that includes the power supply and mounting hardware, but the components are also available separately. The emitter panel supports delivering data to the user in three ways:

- Assistive Listening, commonly called HI for Hearing Impaired audio
- Audio Description, commonly called VI for Visually Impaired audio
- Closed Captions, text of dialog and sounds to private display receivers

Each of these three types of data uses a separate RF carrier. The MiT **IRC** series audio transmissions use standard frequencies of 2.3 MHz and 2.8 MHz to drive the MiT model **IRH** headphones and other standard IR receivers.

The MiT **IRC** emitter series transmits captions delivered to it in a Digital Cinema Package (DCP) when played on a standard digital cinema system that complies with standards SMPTE ST 430-10 and ST 430-11. In addition to captions from a DCP, the **IRC** can transmit captions for a *live* event. The live captions are entered via a web page, or from a script, or through a command to the **IRC** using TCP protocol. For more information on live captions, see the Operation section.

1.1 Important Safety Information

There are few safety concerns with this product:

- Service or maintenance should only be performed by someone with the appropriate experience.
- The device uses 32VDC power which shouldn't cause any serious injury but could provide a painful shock. Always make sure power is disconnected from the unit before opening the cover.
- During use, the emitter transmits Infrared (IR) radiation from its front surface. The amount of radiation shouldn't be harmful to people if exposed for a brief period, but to be safe MiT recommends keeping your eyes and face several feet away from the front of the unit while the device is in operation. If you are servicing or testing the unit with power on, we recommend facing it away from yourself and others.

1.2 RoHS Statement

All of the materials and components used in the manufacture of the **IRC** products are in compliance with the Restriction of Hazardous Substances Directive 2002/95/EC adopted in 2003 by the European Union.

1.3 Model Types

Various models of emitters are available for different environments. These are listed below with a brief description of the typical use. Note that IR coverage varies widely with the environment.

- **IRC-B & IRC-E** The model **IRC-B** is the Basic emitter unit and has no network connectivity. The **IRC-E** model includes an Ethernet network card to receive caption data from a server. Both models use IR LEDs with the standard beam angle of 45 degrees. A system installed in an auditorium must have a minimum of one **IRC-E** model in order to receive data from the cinema server. If a second panel is installed, it isn't necessary for it to have a network connection. These emitter panel models are typically mounted in the back of an auditorium. The receivers will then receive a mix of a line-of-sight direct signal from the **IRC** panel, and additional IR reflected from the screen. In non-cinema applications or cinema applications where there is inadequate coverage from the rear of the auditorium, the **IRC** emitter panel may be mounted in the front of the auditorium, typically to the side of the screen or stage.

- **IRC-N** This is a Narrow angle version of the emitter panel that uses IR LEDs with a beam width of 6 degrees instead of the usual 45 degrees. This narrower beam angle results in increased reflection from the cinema screen (10 to 40 times more). The **IRC-N** model should *only* be used in screen reflection applications. The **-N** Narrow model is to be mounted in the rear of the auditorium and carefully aimed at the center of the screen. The -**N** model always includes the Ethernet communication board as standard. For more information about using the narrow beam emitter model, see MiT document R000302.

As with the standard **IRC** model, a second -**N** model may be ordered to improve coverage or reception. In a dual-emitter installation the same **IRC-N** model is used for both emitter panels. For more information on dual installations see Section 2-2.

1.4 MiT SKUs / Part Numbers

MiT p/n	Description	Previous part no.
A000901-001	Kit, Model **IRC-B**, IR Emitter, Basic, w/hardware (no Ethernet Card)	UPC-28
A000901-002	Kit, Model **IRC-E**, IR Emitter, w/ HW & Ethernet card (CC decoding)	UPC-28C
A000901-003	Kit, Model **IRC-N**, IR Emitter, w/ HW & Ethernet card, Narrow beam	UPC-28C-N
A000901-101	Panel, Model **IRC-B**, IR Emitter, Basic (panel only, no acc. or hardware)	IRC-28
A000901-102	Panel, Model **IRC-E**, IR Emitter w/Ethernet (panel only, no acc. or hardware)	IRC-28C
A000901-103	Panel, Model **IRC-N**, IR Emitter w/Ethernet, Narrow (panel only)	IRC-28C-N
A000903-001	Kit, IRC Wiring (CAT 6 network, audio, and power cables, 50' each)	--

A000905-001	Kit, Accessories & H/W, Single (P/S, mount brackets, N. Am. pwr cord, screws) (this ACC kit is included in kit p/n A000901-001, -002, & -003)	--
A000905-002	Kit, Accessories & H/W, Dual Std. (P/S, mount brackets, N. Am. pwr cord, screws)	--
A000905-003	Kit, Accessories & H/W, Dual Narrow (P/S, mount brackets, N. Am. pwr cord, screws)	--
A000906-001	Accessory, Swivel Wall Bracket (an extra set, same bracket already included in kits)	--
A000930-001	Kit, Box Office / Lobby (Includes standup sign& static cling window sign)	--
C000933-001	IRC Bracket, Dual mount, Standard (with bends, wide angle coverage) (Included in Acc kit p/n A000905-002)	--
C000933-002	IRC Bracket, Dual mount, Narrow (no bends, narrow angle coverage) (Included in Acc kit p/n A000905-003)	--

The above part numbers all reflect the North American models, unless otherwise indicated. Contact MiT for other part numbers.

Figure 1-1 shows the components included in the **IRC** kits, A000901-0xx and A000905-001. Figure 1-2 shows the components included in the Box Office kit.

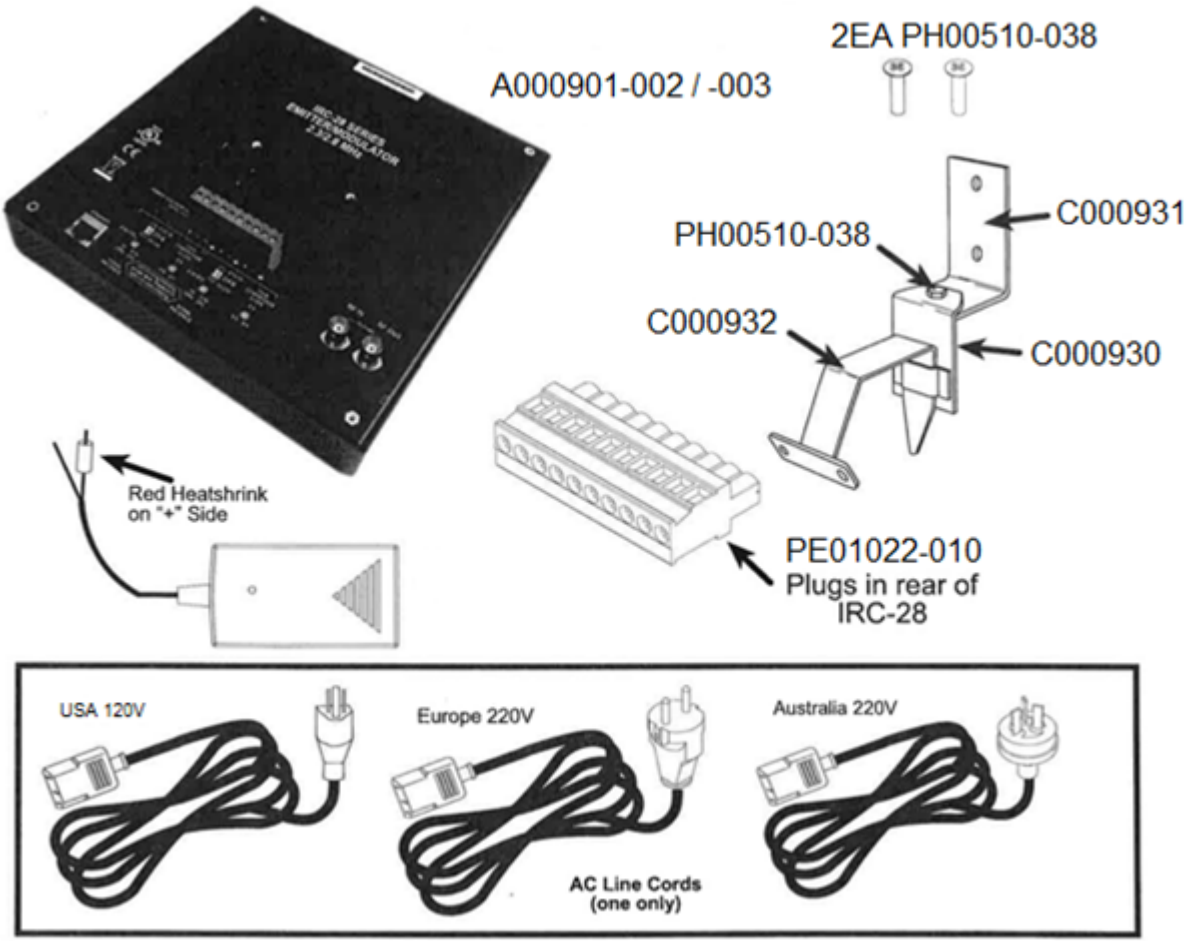


Figure 1-1: IRC Kit contents

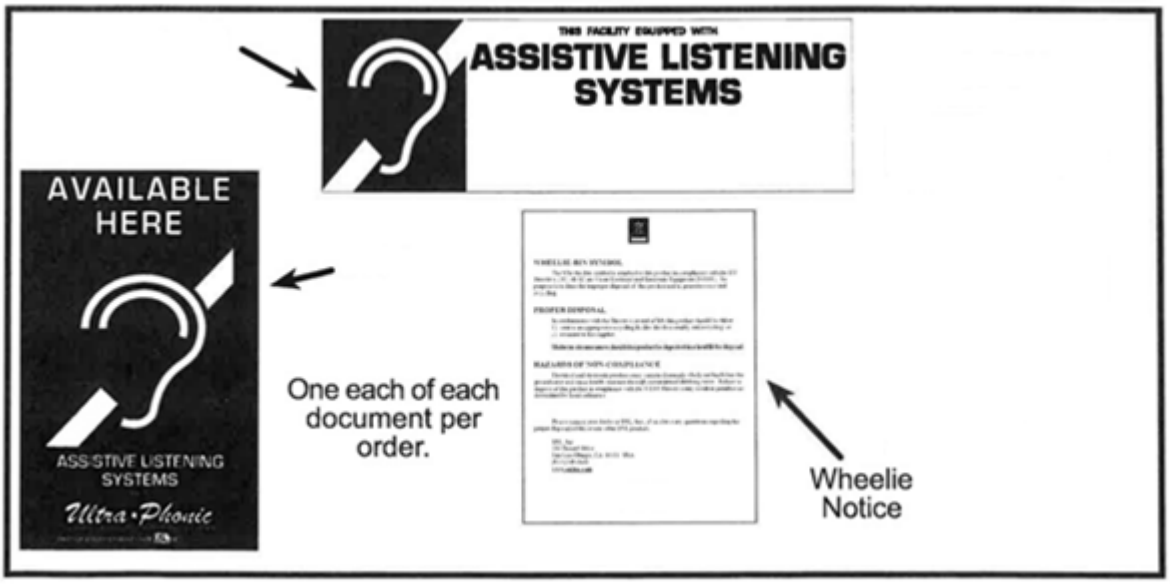


Figure 1-2: Box Office / Lobby Kit contents

2. Installation Guidelines

2.1 Model Selection

In most cinema applications, a single **IRC-E** or **IRC-N** emitter model mounted on the rear wall of the auditorium and aimed towards the screen results in good coverage of the auditorium. A single **IRC** unit is usually sufficient for theaters up to 300 seats. The **-N** (narrow beam) model will provide better coverage because more IR is reflected from the screen (see MiT document R000302 for more information on using the Narrow model).

2.2 Dual Emitters: Master & Slave Panels

In theaters with more than 300 seats or in case of poor line-of-sight to every seat, the coverage of either the Standard angle or Narrow angle model can be improved further by adding a second **IRC** emitter panel. When using two Standard emitter panels, the second unit does not require the network board contained within the **IRC-E**. In a dual installation the **IRC-E** unit is the “master” unit, the second **IRC-B** unit is the “slave” unit. Conversely with the **–N** narrow model, you also have Master and Slave units. Although both units will have the Ethernet board included, the board is only used in the Master unit.

In both Standard and Narrow angle models, the three signals that modulate the IR LEDs are generated in the Master panel and carried to the Slave panel over a 75 ohm coaxial cable (such as RG-59/U) with BNC connectors. The *only* connections made to the Slave panel are power and the coax RF cable. Also all of the audio adjustments are made on the Master unit, no configuration is required on the Slave unit, as that circuitry is all bypassed on the slave (audio adjustments are covered in Section 3).

The best performance is usually obtained with the panels at the same location, using the dual panel mounting bracket provided. However in some situations a single panel location may not be able to cover the entire area due to shadows. In such a situation, the panels may be separated. The master

and slave panels can be separated by up to 100 feet (30 meters) to provide signal into a shadowed area. Cables longer than 100 feet are discouraged as the phase delay through the cable may result in the IR signals subtracting instead of adding, resulting in poor reception.

The Standard IR LEDs have a beam width of 45 degrees. The dual mounting bracket provided for an installation of Standard IRCs aims the two panels 20 degrees apart, for a total horizontal angle of coverage of about 65 degrees. Conversely, the mounting bracket used for a dual Narrow model installation is flat, so the beams from both panels are parallel. This is so that the beams from both emitters may be aimed as close to the center of the screen as possible.

2.3 IRC Emitter Panel in Front (Direct Reception)

In applications without a cinema screen or where screen reflection does not provide adequate coverage, a single or dual **IRC** emitter can be installed in front of the auditorium for direct reception of the IR by the receivers.

NOTE: The **-N** (narrow beam) model should not be used for direct reception, they should only be used for screen reflection.

NOTE: under very dark conditions in the theater, a dim red glow can be visible coming from the emitter panel while it's in operation. This should be considered for acceptability before finalizing the placement of the **IRC** panel at the front of the room.

Generally, if the theater patron can see the panel, they will receive a good signal. The expected range at various angles with the standard angle IR panel(s) is shown in Table 2-1.

Table 2-1: Direct Radiation (Front Mount) Coverage

Angle (degrees)	IRC Single Panel		IRC Dual Panel	
	Distance (feet)	Distance (meters)	Distance (feet)	Distance (meters)
0	200	61.0	276	84.0
10	195	59.4	255	77.8
20	159	48.4	219	66.8
30	100	30.5	171	52.1
40	63	19.3	110	33.4
50	45	13.6	69	21.1
60	28	8.6	45	13.6

2.4 Audio Wiring

The audio inputs on the **IRC** unit are differential analog inputs (balanced). Use two-pair shielded cable such as Belden 9451DP to connect the emitter unit to the audio source (typically a cinema sound processor). Use of two-pair shielded cable is recommended even if the audio source is unbalanced. Connect the cable shields at both ends of the cable to minimize the common mode voltage at the **IRC** audio inputs. If the source is unbalanced, connect the low side of the audio input (the wire connected to the **-** terminal on the **IRC**) to the shield at the audio source, not at the **IRC** panel. This wiring allows the **IRC** differential input to subtract out noise due to current in the cable shield.

2.5 Power

The **IRC** series emitter panels are powered by an external 32VDC power supply. Note that two supplies are required for a dual panel installation. The voltage reaching the panel must be at least 26.25V. Use of 18 AWG (0.823 Ø [mm²]) or larger wire is recommended for up to 150 feet (45 meters) of cable.

3. Configuration

It is easier to configure and test the **IRC** panel on the projection booth floor instead of at the top of a ladder in the auditorium. In a theater where multiple panels need to be configured, a set of test cables can be made to connect to each **IRC** panel in sequence.

3.1 Audio Levels

With the **IRC** unit connected to the sound processor, play some typical content. Adjust the input level control of each channel such that the signal presence LED for that channel just flickers and is not lit continuously. Try the input range DIP switches in each position (both up or both down) and adjust the input level again. Listen to the audio on a pair of IRH headphones to determine which setting sounds best.

Adjust the compression control for each channel as desired. A typical setting is 2:1. A higher compression ratio improves the signal to noise ratio, however excessive compression can result in distortion.

3.2 Captioning Configuration

General note for the remainder of this section: In a Dual **IRC** installation where both **IRC** units have an Ethernet card installed (for example the **–N**arrow model which is *only* available with the network card included), you only need to do the configuration on the *Master* unit. There is no need to do any configuration on the *Slave* unit. The network input, analog audio inputs, and the configuration settings on the *Slave* unit are not used. An exception to this might be if the user wanted to be able to change over quickly, reversing the Master and Slave arrangement in an auditorium in case of a failure of the network card on the Master **IRC**. In that case it might be useful to configure both units with all the same information and settings at the time of initial installation. However also see the information about the IR **Caption Carrier** setting under Sec 3.4.

3.3 Configuration Procedure

Configure a laptop to be on the 169.254.x.x subnet. A typical IP setting would be 169.254.1.123.

Connect the laptop to the Ethernet jack on the **IRC**. Open a web browser on the laptop and go to 169.254.1.1 . The **IRC** home page should appear (see Figure 3-1).

Note: The screen images below reflect what appears in the current software release at the time of this writing. If you have a newer or older version of software you may see different settings.

Figure 3-1: IRC Home Page

Click System Configuration at lower left to reach the first configuration page. The browser will ask for a username and password. The username is **admin** and the password is **ultra**.

3.4 DCS Configuration

Click the DCS Configuration link. The screen shown in Figure 3-2 will appear.

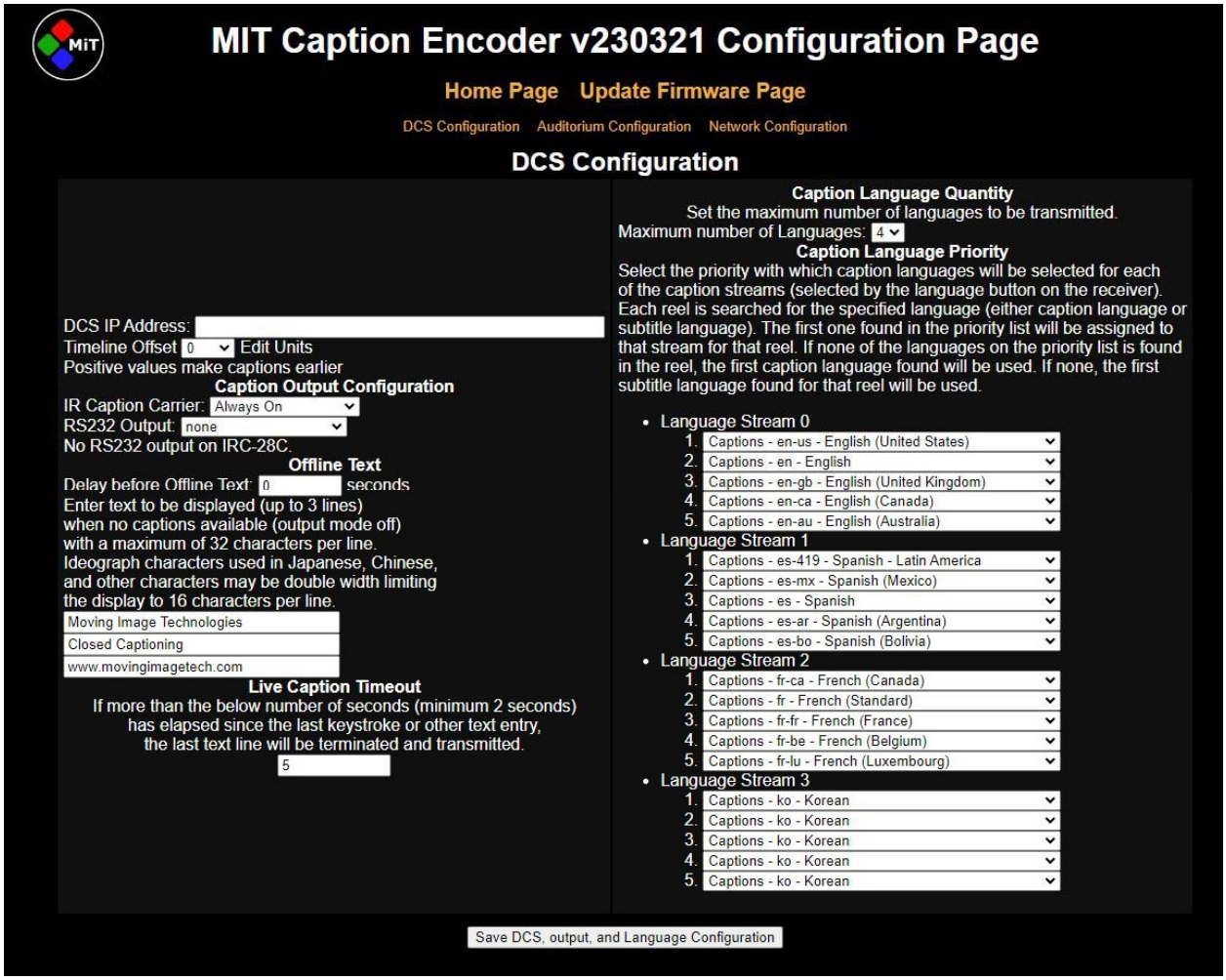


Figure 3-2: DCS Configuration

- **DCS IP Address** - Enter the IP address for the digital cinema server. This is typically the address on the “auditorium network.” You can test the IP address using Putty or Tera Term to connect to that address on port 4170. If the server accepts the address and outputs the name of the server along with some binary data, you have the correct IP address.
- **Timeline Offset** - This is normally set to zero, but it can be set to adjust the synchronization between the captions and the content. The offset is in edit units which is the same as frames for 2D content. A positive offset makes the captions earlier.
- **IR Caption Carrier** - This may be set to off to never transmit captions, always on, or on connect to DCS. Normally this is set to “On Connect to DCS.” The caption data will be transmitted whenever the **IRC** panel is able to connect to the digital cinema server on port 4170. If content is not playing, the offline text (see below) or live captions (also below) will be transmitted to receivers. If you are setting up the Slave unit in a dual-emitter install to be ready for a fast swap as described in Sec 3.2 above, this field must either be set to On Connect to DCS, or Off (if you set the slave unit to On Connect to DCS, be sure **not** to connect an Ethernet cable to the unit).
- **RS232 Output** - The Ethernet card in the **IRC-E** emitter panel has an RS232 output that can be used in other products. However it is not used in the **IRC-E**, so this should be set to “none.**”**

- **Offline Text** - The **IRC** has the capability to transmit static text when no timed text is being sent from the cinema server (the playback is stopped or paused). Very often this is set to a “welcome to the theater” text. Or it may be a troubleshooting message warning that if the user sees this text while a movie is playing there is a problem with the system and to notify the manager. The parameters for this offline text are configured in this area of the page.
    - **Delay Before Offline Text** - Some digital cinema servers send a playback stop request (SetOutputMode Disabled) between compositions. To keep the offline message from popping up between trailers, this delay is normally set to 10 seconds. The offline text will start to be transmitted 10 seconds after the playback stops.
    - **Text** - Enter the offline text to be transmitted here. The text can be up to three lines. For many languages, up to 32 characters can be on a line. Some languages, however, use wider characters and may limit the number of characters per line to 16. Most common Unicode characters are supported.
- **Live Captioning Timeout** - The MiT closed captioning system supports live captioning where caption text is typed into a web form (or entered through speech to text software). The live caption text is transmitted as each line of text is completed. If a line is not completed (often the case with speech to text software when there is a pause), the system will transmit the incomplete line after this timeout.
- **Caption Language Quantity** - The system can transmit captions in four languages. The user selects the language to view using the language switch on the receiver. If a language is not supplied in the digital cinema package, no captions will appear when that language is selected. This may add to user confusion. To limit user confusion, the number of languages transmitted can be reduced. If this value is set to 1, only language stream 0 will be transmitted. The caption receivers will scroll only through the languages received.
- **Caption Language Priority** - A digital cinema package can include captions in up to 6 languages. The language priority list assigns languages to caption streams that are transmitted to the receivers. There may be several languages that you want to send to one stream. For example, one trailer may have generic English (“en”), another may have U.S. English (“en-US”), and another may have British English (“en-GB”). The language variations to be sent to each stream are set on this page. The system evaluates languages on a reel-by-reel basis to assign captions to the appropriate stream.
- **Save DCS, output, and Language Configuration** - Click this button when the configuration on this page is complete.

3.5 Auditorium Configuration

Click Auditorium Configuration to set auditorium data. The screen shown in Figure 3-3 should appear.

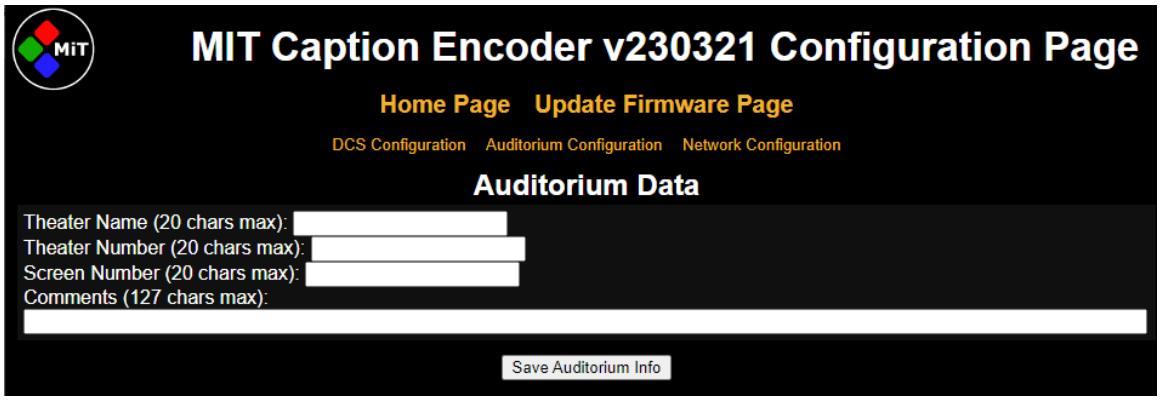


Figure 3-3: Auditorium Configuration

Note that the information entered on this page is not used by the **IRC**. It is only provided as a convenience to hold information helpful to the installer or end user. All fields are optional.

- **Theater Name** - Enter the name of the theater. It can be up to 20 characters.
- **Theater Number** - Enter the theater number or site number. It can be up to 20 characters.
- **Screen Number** - Enter the screen or auditorium number. It can be up to 20 characters.
- **Comments** - Enter any useful comments about the installation. The comments can be up to 127 characters.
- **Save Auditorium Info** - Click this button when the above information is ready to be saved.

3.6 Network Configuration

Click the Network Configuration link. The screen shown in Figure 3-4 should appear.

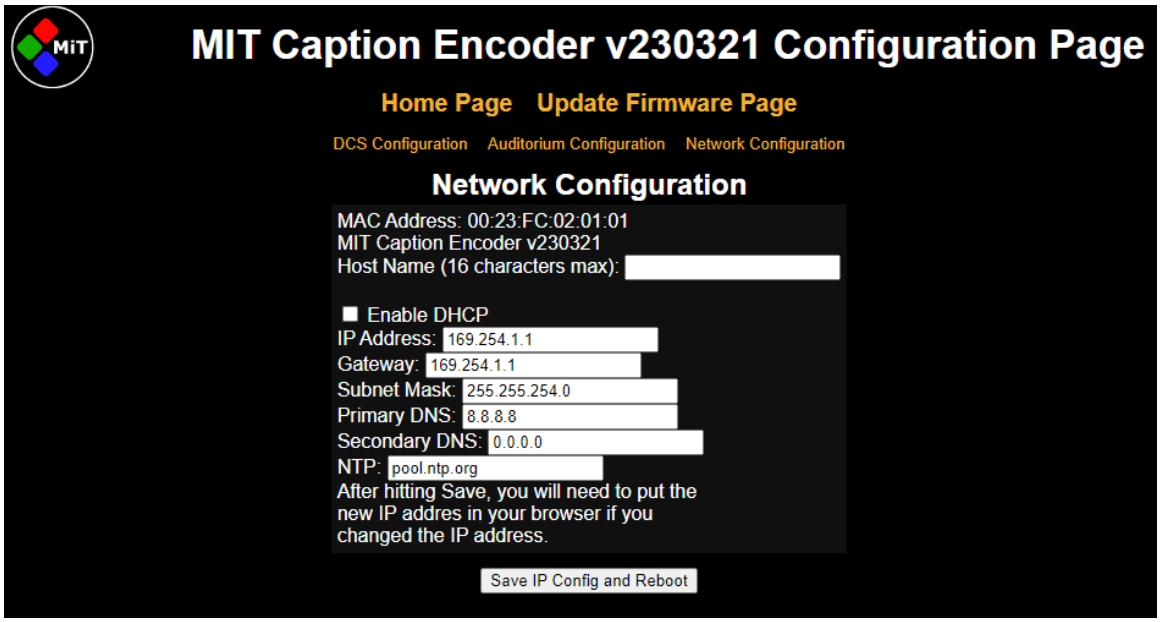


Figure 3-4: Network Configuration page

- Host Name - Set the NET BIOS hostname. This is how the panel will be identified to external devices and by the Ethernet Discoverer (go to the following page to obtain the Ethernet Discoverer app: http://www.movingimagetech.com/product/irc-28/
- **Enable DHCP** - Check this box to enable the Dynamic Host Configuration Protocol. The **IRC** will be assigned an IP address by a DHCP server. This is very rare in cinema applications. Normally this box is left unchecked.
- **IP Address** - Enter the IP address the **IRC** is to have on the auditorium network. Make sure this address does not conflict with anything else on the same network. Ensure the address is recorded in the theater documentation so the **IRC** can be reached over the network.
- **Gateway** - Set the IP address that is used to reach devices outside the subnet.
- **Subnet Mask** - Set the subnet mask. When a bit of the IP address is different from the corresponding bit of the IP address you are connecting to AND the corresponding bit of the subnet mask is set, the **IRC** will reach that device through the gateway. Otherwise the device is on the same subnet, and the **IRC** will communicate with the device directly.
- **Primary DNS** - The **IRC** needs to access a DNS server if the NTP address (below) is a hostname instead of an IP address. If the **IRC** can access the Internet through a router at the theater, the Google DNS at 8.8.8.8 can be used. Other DNS servers can also be used. If DNS is not to be used, set this field to 0.0.0.0.
- **Secondary DNS** - If the **IRC** cannot reach the primary DNS server, it will try the secondary server. Another Google DNS server is 4.4.4.4. If no DNS is to be used, set this to 0.0.0.0.
- **NTP** - The **IRC** has an internal real time clock. It is set by periodic polls of a Network Time Protocol server and through the Auxiliary Content Synchronization Protocol (SMPTE ST 430-10) announce request sent by the digital cinema server. If the **IRC** is able to reach the Internet, use of time.nist.gov is suggested. Many digital cinema servers also include an NTP server. Use the address of the digital cinema server if Internet access is not available. An entry of 0.0.0.0 disables NTP on the **IRC**.
- **Set IP Config and Reboot** - Once the above information is complete, click this button to save the network configuration and reboot the **IRC** with the new network settings. The browser will be redirected to the new IP address, but it will not be able to make a connection if the new IP address is on a different subnet.

4. Initial Test

After configuring the system, it's preferred to test it before doing the final installation.

- Connect the **IRC** and laptop to the auditorium network switch.
- Open a web browser pointing to the previously set **IRC** IP address. The home page should appear.
- Click Debug Info, then HTML Log. It will take several seconds for the log to download. When the download is complete, the column with local time will appear. See Figure 4-1.

2939	0	1969-12-31 18:00:00	0x00000000	Reset due to BOR, POR
2940	0	1969-12-31 18:00:00	0x00000000	USL Caption Encoder ver 200601
2941	0	1969-12-31 18:00:00	0x00000000	ExtFlashID = 0x202015 (M25P16)
2942	0	1969-12-31 18:00:00	0x00000000	EU Clock: XT
2943	0	1969-12-31 18:00:00	0x00000000	EU Clock: XT
2944	0	1969-12-31 18:00:00	0x00000000	New IP Address: 10.126.2.11
2945	1591152310	2020-06-02 20:45:10	0x00000000	NTP adjusted RTC 1591152310 seconds. PR2=154731
2946	1591152320	2020-06-02 20:45:20	0x00000000	CSP connecting to 10.108.129.70:4170
2947	1591152320	2020-06-02 20:45:20	0x00000000	CSP connected to 10.108.129.70:4170
2948	1591152320	2020-06-02 20:45:20	0x00000003	Announce DCS: QSC, LLC. CMS-5000
2949	1591152149	2020-06-02 20:42:29	0x00000003	CSP announce adjusted RTC -171 seconds. PR2=154741
2950	1591152149	2020-06-02 20:42:29	0x00000003	Announce Time: 1591152149
2951	1591152150	2020-06-02 20:42:30	0x00000007	GetNewLease: 60 seconds
2952	1591152150	2020-06-02 20:42:30	0x00000007	Lease Active
2953	1591152151	2020-06-02 20:42:31	0x00000007	Received RPL URL of subtitle/1591151562/dcsubtitle.xml, PlayoutID=5ed70bca
2954	1591152151	2020-06-02 20:42:31	0x00000007	ResourceMapFifo contains 284 bytes and has 116224 bytes free
2955	1591152151	2020-06-02 20:42:31	0x00000007	Loaded RPL URL with PlayoutID=0x5ed70bca
2956	1591152151	2020-06-02 20:42:31	0x00000007	Fetching RPL at subtitle/1591151562/dcsubtitle.xml
2957	1591152152	2020-06-02 20:42:32	0x00000017	Fetching http://10.108.129.70/subtitle/1591151562/dcsubtitle.xml
2958	1591152152	2020-06-02 20:42:32	0x00000017	Connecting to http://10.108.129.70:80/subtitle/1591151562/dcsubtitle.xml
2959	1591152153	2020-06-02 20:42:33	0x01000017	Output mode set to enabled
2960	1591152153	2020-06-02 20:42:33	0x01000017	Disconnected from http://10.108.129.70:80/subtitle/1591151562/dcsubtitle.xml
2961	1591152153	2020-06-02 20:42:33	0x01000017	Got 3424 bytes from http://10.108.129.70:80/subtitle/1591151562/dcsubtitle.xml
2962	1591152153	2020-06-02 20:42:33	0x01000027	RPL /ResourcePresentationList found
2963	1591152153	2020-06-02 20:42:33	0x01000027	RPL Language Discovery: TimelineOffset=15044, language=en, ResourceType=ClosedCaption
2964	1591152153	2020-06-02 20:42:33	0x01000027	RPL Language Discovery: TimelineOffset=19070, language=ru, ResourceType=MainSubtitle
2965	1591152153	2020-06-02 20:42:33	0x01000027	RPL Language Discovery: TimelineOffset=19070, language=en, ResourceType=ClosedCaption
2966	1591152153	2020-06-02 20:42:33	0x01000027	RPL Language Discovery: TimelineOffset=22727, language=ru, ResourceType=MainSubtitle
2967	1591152153	2020-06-02 20:42:33	0x01000027	RPL Language Discovery: TimelineOffset=22727, language=en, ResourceType=ClosedCaption

Figure 4-1: Typical HTML Log Display

- If you scroll down to the bottom of the log, a set of entries similar to those in Figure 4-1 should be present. The first few entries after power up will have a date in 1969 or 1970. The **IRC** can get the time and date from the Digital Cinema Server and the NTP server. The log entries in Figure 4-1 show the following proper operations:
    - The device was reset through a brownout or power-on reset.
    - The version number of the firmware is logged.
    - The external flash that holds the log, configuration, and other information is identified.
    - The edit unit clock is crystal-controlled (older systems used an RC clock).
    - The IP address has been set.
    - The real time clock has been set by the NTP server. The amount of adjustment is shown. In addition, each time the time is adjusted, the “period register” that determines the speed of the real time clock is adjusted in the right direction to make the real time clock speed correct.
    - The **IRC** connected to the Digital Cinema Server and was successful.
    - The **IRC** received an announce request from the Digital Cinema Server. The announce message includes a timestamp, so the **IRC** real time clock is adjusted to agree. Note that unless the DCS is synchronized with an NTP server, it will generally drift from the correct time. The announce request is received rarely (only when the **IRC** makes a new

connection to the DCS), while the NTP server is polled every 10 minutes. Almost all log entries will have time based on the NTP server.

- In the next several lines, you can see the **IRC** received an RPL location, fetched the RPL, then discovered the languages used in the RPL.

The log shows that the **IRC** is successfully communicating with the Digital Cinema Server and the NTP server.

- Play content with HI and VI audio, and with closed captions. Most movies now have these tracks. Test content is also available at http://www.movingimagetech.com/product/irc-28/.
- HI and VI audio should be audible on the IRH headphones.
- Closed captions should appear on the closed caption receiver display.

5. Installation

Once the **IRC** has been configured and tested it can be installed in the auditorium, observing the requirements described in the rest of this section.

5.1 Standard vs Narrow

As discussed in Section 2, the **IRC** is typically mounted on the rear wall of the auditorium and aimed at the screen. If an **IRC-N** (narrow) model is being installed, aiming the panel is fairly critical since the beam width is quite narrow (6 degrees). See the additional instructions in MiT document R000302.

5.2 Connections & Adjustments

The location of **IRC** connections, indicators, and adjustments are shown in Figure 5-1 and 5-2.

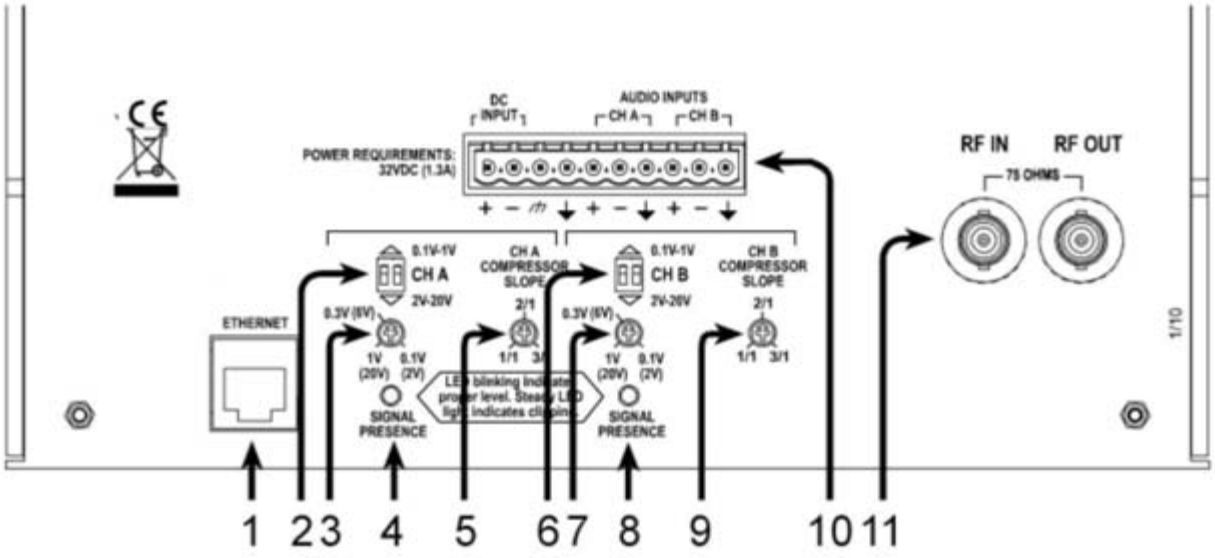


Figure 5-1: Rear Panel Features

1. **Ethernet Connector** - Connect to the auditorium Ethernet switch. Typically the **IRC** is connected to the *Management* network (Note: Some servers allow you to select which network the **IRC** is connected to, others don't).
2. **Level Range A** - Set both switches up or down to get the best sound quality when the input level control (3) is adjusted until the signal presence LED (4) just flickers.
3. **Level A** - Adjust this input level control until the signal presence LED just flickers.
4. **Signal Presence LED A** - This LED should flicker on the loudest parts of the content. It should not be lit continuously (signal too high causing distortion) or not ever be lit (signal too low resulting in poor signal to noise ratio).
5. **Compression Slope A** - Adjust as necessary to reduce the dynamic range of the transmitted audio thereby improving the signal to noise ratio. A typical setting is 2/1.
6. **Level Range B** - Set both switches up or down to get the best sound quality when the input level control (3) is adjusted until the signal presence LED (4) just flickers.
7. **Level B** - Adjust this input level control until the signal presence LED just flickers.
8. **Signal Presence LED B** - This LED should flicker on the loudest parts of the content. It should not be lit continuously (signal too high leading to distortion) or not ever be lit (signal too low resulting in poor signal to noise ratio).
9. **Compression Slope B** - Adjust as necessary to reduce the dynamic range of the transmitted audio thereby improving the signal to noise ratio. A typical setting is 2/1.
10. **Audio and Power Connector** - Make the connections per the following pinout:

    Pin 1 - Power Supply Positive - Positive lead of 32VDC 1.3A power supply. This lead is normally red. If the power needs to be extended, use 18 AWG (0.823 Ø [mm²]) cable for runs of up to 150 feet (45 meters). Each **IRC** (such as in a dual panel system) needs its own power supply.

    Pin 2 - Power Supply Negative - Negative lead of the 32VDC 1.3A power supply.

    Pin 3 - Earth Ground - No connection required

    Pin 4 - Chassis Ground - No connection required.

    Pin 5 - Channel A High - Connect the high side of the channel A audio.

    Pin 6 - Channel A Low - Connect the low side of the channel A audio. Use of 2-pair shielded cable similar to Belden 9451DP is suggested. Connect the shield at both ends of the cable to minimize the common mode voltage on the input to the **IRC**. If the audio source is unbalanced, connect the low side wire to the shield *at the audio source*. Making the connection at this end of the cable instead of at the **IRC** end allows the differential input of the **IRC** to subtract out noise due to shield current.

    Pin 7 – Earth Ground / Channel A Shield - Connect the shield of the channel A cable.

    Pin 8 - Channel B High - Connect the high side of the channel B audio.

    Pin 9 - Channel B Low - Connect in the same manner as the Channel A Low input.

    Pin 10 – Earth Ground / Channel B Shield - Connect the shield of the channel B cable.

11. **RF In** - Radio frequency signals connected to this input will drive the data transmitted by the IR LEDs. This connector is only used on an **IRC** *slave* unit to receive signals from the **IRC** master panel. It is not used on an **IRC** *Master* unit. NOTE: In the case of dual units where *both* have Ethernet cards, for example with the **IRC**-**N**arrow model that's only available with the network card included, there's still a Master and Slave. The data to be transmitted by IR is connected from the server to the network input on the Master, and then the Slave unit gets its signal from its **RF In** connector.
12. **RF Out –** This BNC connector provides an RF signal that includes the two audio channels plus the closed caption data. Use 75 ohm coaxial cable to connect this to the **RF In** connector on an **IRC** slave unit. Normally the slave unit is mounted on the same bracket as the master panel with a short piece of cable between the two. As noted in Installation Options (Section 2.2), it's possible for the slave panel to be separated from the master panel by up to 100 feet (30 meters).

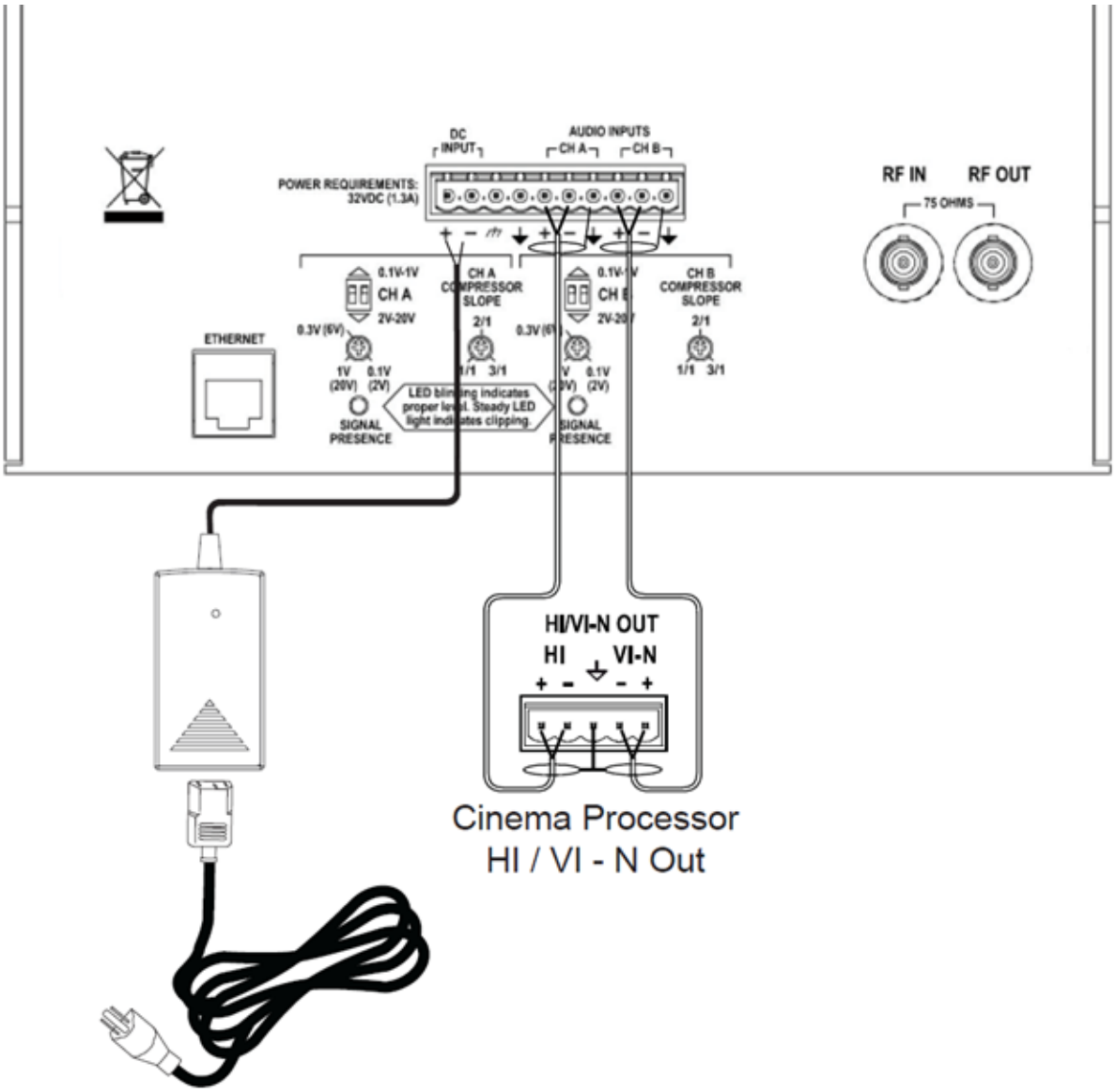


Figure 5-2: Power & Audio Connections

6. Operation

6.1 Digital Cinema Playback

Once configured, the system should transmit the caption carrier and bring up the offline message whenever the digital cinema server is on. Audio carriers are turned on when audio is detected. The carriers stay on 30 minutes past the last detected audio. When playback starts, the offline message will disappear and captions will appear on the closed caption receivers.

6.2 Live Captions (manual entry)

Live captions can be typed in on the live caption web page (shown in Figure 6-1 below). Live captions replace the offline message. Live captions are disabled when digital cinema content is playing. Live captions can be used without a digital cinema player.

Figure 6-1: Live Captions

The checkboxes at the bottom of the page determine which caption language stream the captions will be sent to. The captions can be sent to one or any combination of the streams. When multiple languages of live captions are used, there will typically be several individuals acting as transcribers, one for each language desired to support. Each of the individuals will have this web page open with the appropriate checkboxes checked.

Captions are transmitted when a line is completed (carriage return or [enter] pressed), on a user-configurable timeout (see the DCS Configuration page, Section 3.4), or when a line exceeds 32 characters. When a line exceeds 32 characters, it is split at the last space before the 32-character limit. The first part of the line is transmitted and the remainder of the line remains awaiting further text entry or the timeout.

The system supports UTF-8 characters, and the **CCR** receivers and **CCH** glasses support about 65,000 characters in the Unicode Basic Multilingual Plane. The web interface is not aware of how wide the characters will be on the caption receiver, so care must be taken to ensure the line of text fits on the

display. The caption receivers attempt word wrap, but in some character sets this can be difficult since there are no spaces between ideographs.

The caption receiver displays three lines of text. As each line is completed on the **IRC** live captions page, the last three lines are transmitted. On receiving new live caption data, the caption receiver blanks and then displays the new three lines of text. The display can be blanked by pressing the enter key three times.

Live captions can also be passed into the **IRC** through a TCP connection on port 10001. The command is **irc.sys.caption**. Fields are delimited by the tab or pipe (|) character. The next field is a bitmap of the desired language streams. Selecting 1 puts the caption line on the first language, 2 on the second, 4 on the third, and 8 on the fourth language stream. Add these numbers together to put the caption on multiple language streams. The final field is the caption text. It is UTF-8 text and is terminated with a carriage return. Since the pipe character is a field delimiter, it cannot be used in a caption. The command sends one caption line. Each subsequent command results in the last three lines being sent and displayed. A typical command string to transmit a live caption line is the following:

irc.sys.caption|1|This is a live caption

```
1       This is a live caption
```

6.3 Live Captions (from script)

IRC firmware versions 221123 and later support live captions from a script. The script is a text file with each caption line on a separate line and with a blank line between captions. The text must be UTF-8 encoded. Be aware of the caption line length limits of the **CCR** reader. With most characters, a caption line can be up to 32 characters long. However many Asian characters are twice as wide, limiting lines to 16 characters. A portion of a typical caption script (in English) is shown below:

```
(panting)

(panting)

(orchestra plays
ominous low notes)

(plaintive violin solo returns)

This blade has a dark past.
It has shed much innocent blood.

You're a fool
for traveling alone

so completely unprepared.

You're lucky your
blood's still flowing.

Thank you.

So...

What brings you to the
land of the gatekeepers?
```

The script to be used is loaded from the Live Captions page using the Choose File button in the *Live Captions From Script* portion of the page. The script text will appear in the text box below the Choose File button. An implicit blank line is added before the first caption, and that line is highlighted in blue. When the Next button is clicked, the next caption is highlighted in blue, appears in the window at the top of the page, and is transmitted to the **CCR** units on the language streams selected in the top portion of the page. Clicking Next again highlights the blank line between the two captions, clears the caption window at the top of the page, and clears the display on the **CCR**.

During an event, the operator follows the live action, clicking the Next key to bring up the next caption, and clicking it again to take that caption down. The blue highlight advances through the script showing which caption is being transmitted. Previous and later captions are available below and above the blue highlight. If needed, the operator can go back to a previous caption by clicking the Previous button. A typical Scripted Live Caption screen is shown in Figure 6-2.

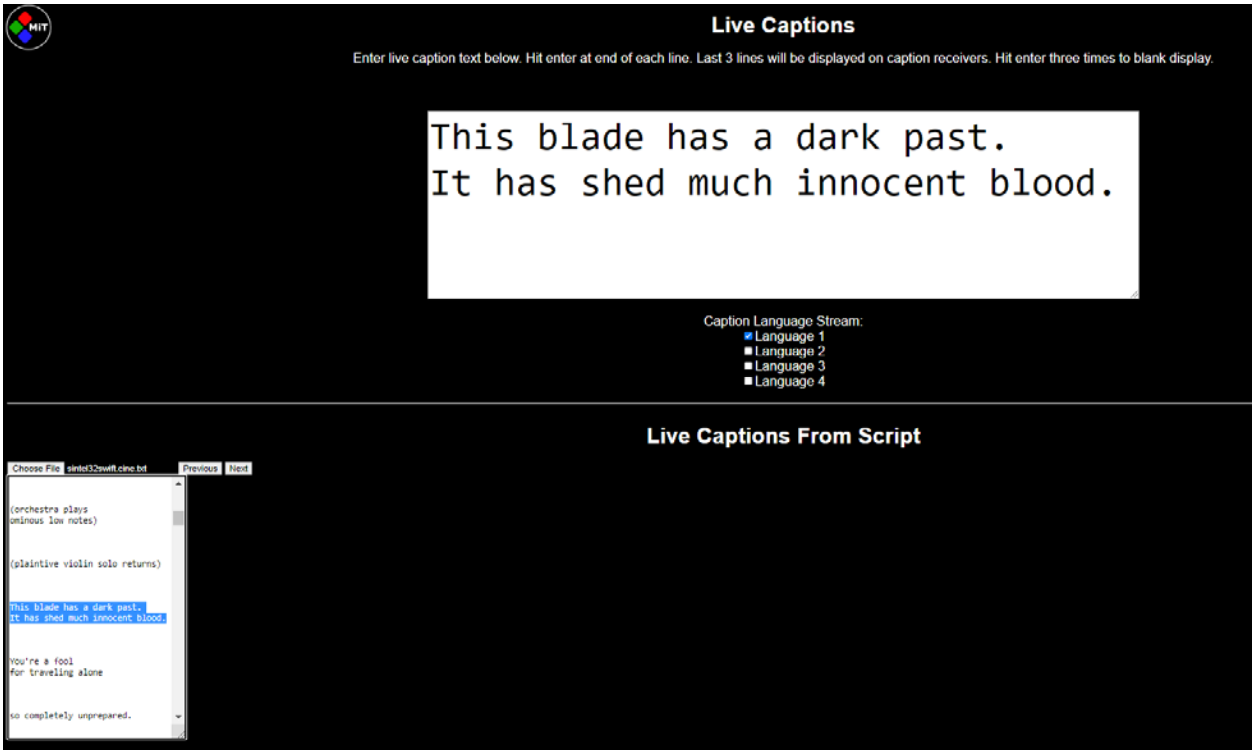


Figure 6-2: Typical Live Caption Screen

6.4 Live Captions (speech to text)

Speech to text conversion software such as **Dragon Naturally Speaking** or The Microsoft speech to text App built into Windows 10 or later can be used with the **IRC**. Place the cursor in the text box on the live captions page, the spoken words will be converted to text and will be transmitted as captions. To activate the windows speech conversion app, press Windows key + H. The word wrap, discussed above, causes each line of text to be transmitted as it is completed. If there is a pause in the speech that is longer than the live caption timeout, the last incomplete line is transmitted.

Be aware the timing of the resulting captions aren't likely to be ideal using this method, there is sure to be some lag between the time the dialogue is spoken and the text string sent. There are also likely to be errors from the speech being interpreted incorrectly by the app. This approach should only be considered as a last resort with content that has no captioning data included with it, or for a live speech being given that doesn't have text for it available.

6.5 Live Captions (alternative content)

MiT is occasionally asked about being able to deliver closed captions in a theater using the **IRC** and **CCR** devices sourced from *alternative* content, that is, non-DCI content (from DVD, BluRay, or live television broadcast for example). Various companies manufacture devices capable of extracting the caption data from a digital video stream. It may be possible to use the caption output from such a device and input it to the **IRC** as Live Captions. However at the time of this writing (August 2023) MiT hasn't tested this capability and doesn't have a solution we can recommend. These captioning devices are marketed to television networks, post production companies and similar facilities, and are quite expensive to purchase. A rental of one of these units may be practical to consider for a one-time event. MiT is willing to assist any of our customers interested in interfacing one of these devices to the **IRC**.

7. Debug Info

The **IRC** provides several debug screens. These are discussed below.

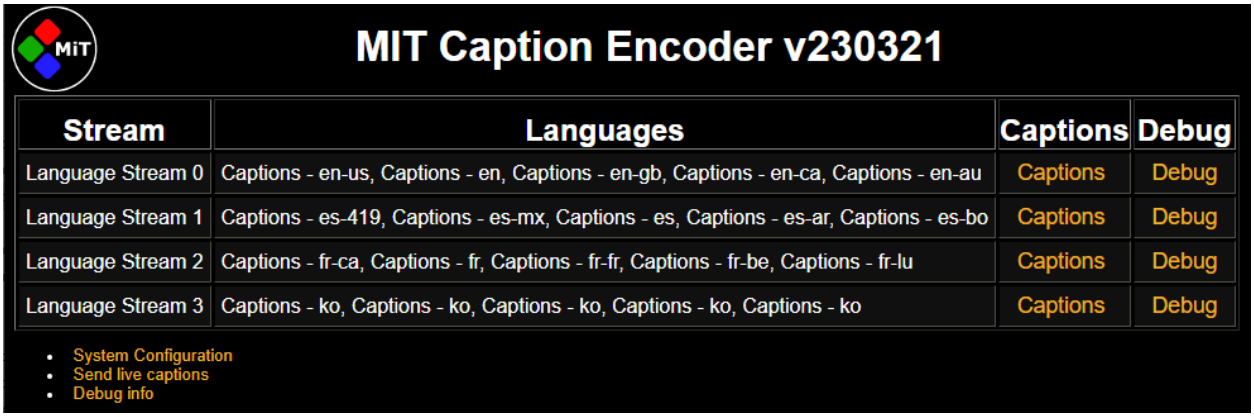


Figure 7-1

As shown in Figure 7-1, the **IRC** home page includes several debug links. The table has a debug link for each of the four language streams that are transmitted to the caption receivers. The languages listed in each row are the language priorities set for that stream on the DCS Configuration Page.

The image in Figure 7-2 shows a typical debug page for a language stream.

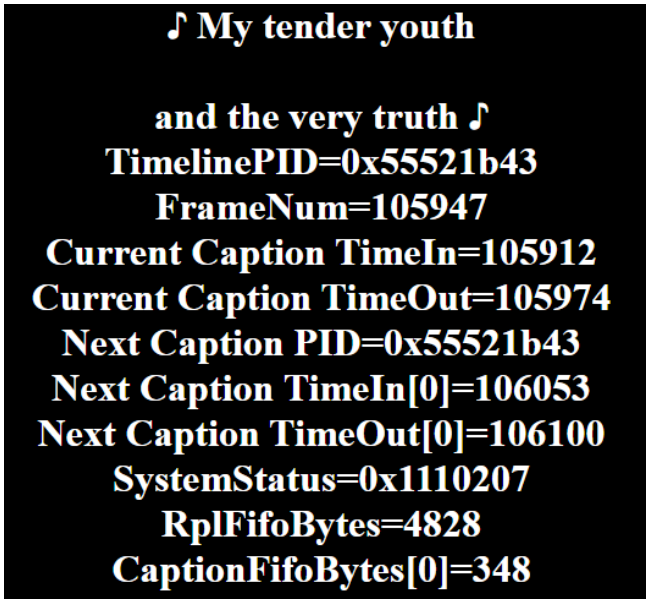


Figure 7-2: Debug Display

The top 3 lines show the current caption. The next line shows the Playout ID of where we are in the playout timeline. The next line shows the frame number (more correctly the editable unit number) of where we are on the current timeline. The next two lines show the TimeIn and TimeOut of the currently displayed caption. The next three lines show the PID, TimeIn, and TimeOut of the next caption that will be displayed. The next line shows the current system status where each digit represents the status of a portion of the system. System Status is discussed later, under HTML Log.

The next line shows the number of bytes in the Resource Presentation List First In First Out buffer. Data is added to this buffer when the digital cinema server sends a SetRplLocation request. The **IRC** pulls the RPL Location from the RPL FIFO, fetches the RPL, parses it, and puts information about each timed text file back in the RPL FIFO. The **IRC** then pulls each timed text record from the RPL FIFO, fetches the timed text file, parses it, and puts the resulting caption data in the Caption FIFO. There is a separate Caption FIFO for each language stream to be transmitted. Data is pulled from the Caption FIFO and transmitted from the TimeOut of the last caption (we no longer need that data) to the TimeOut of the current caption. Data is transmitted repeatedly over this period of time so the receivers can recover from any transmission errors.

When a show is loaded you will observe the RPL FIFO increase in size, then the Caption FIFO will increase in size with the RPL FIFO decreasing. As content is played, the Caption FIFO will decrease in size.

7.1 Debug Screen

Several links and other information are available on the debug screen. See Figure 7-3.

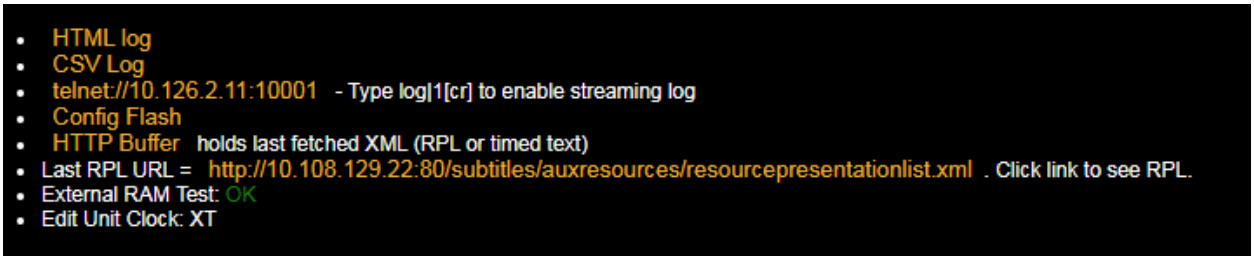
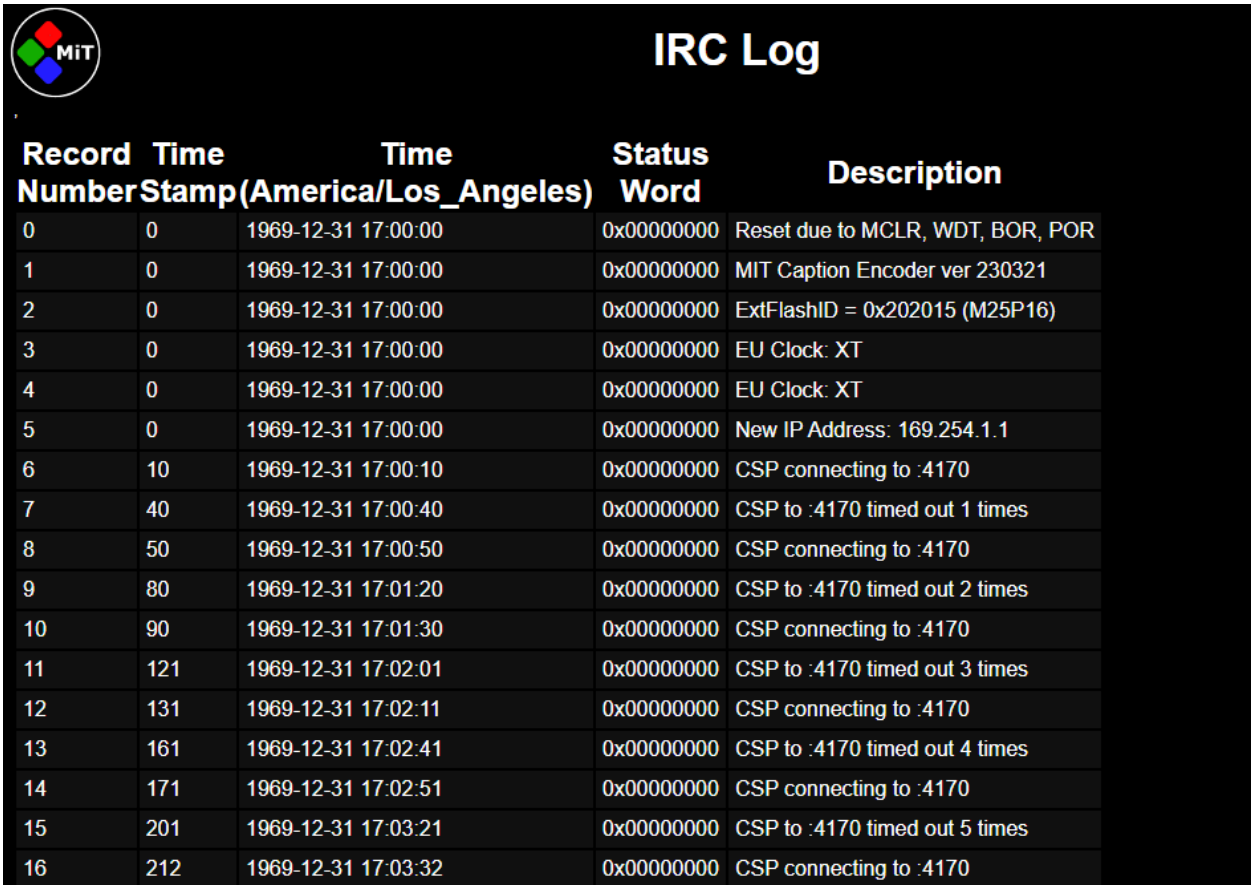


Figure 7-3: Debug Screen

The last two lines show that the external RAM passed its test and that the edit unit clock is crystal-controlled (early units used an RC oscillator). The other links are discussed below.

7.2 HTML Log

The HTML log shows an extensive log of system operation. The log is stored in flash memory. When the HTML log page is selected, the log is parsed and formatted for the HTML display. The log takes several seconds to download. When the download is complete, the browser converts the Unix timestamp to local time. At that time, the local time column will appear along with the time zone from the computer the browser is running on. The log holds 3,840 records. Figure 7-4 shows a portion of a typical log.



IRC Log

Record Number	Time Stamp	Time (America/Los_Angeles)	Status Word	Description
0	0	1969-12-31 17:00:00	0x00000000	Reset due to MCLR, WDT, BOR, POR
1	0	1969-12-31 17:00:00	0x00000000	MIT Caption Encoder ver 230321
2	0	1969-12-31 17:00:00	0x00000000	ExtFlashID = 0x202015 (M25P16)
3	0	1969-12-31 17:00:00	0x00000000	EU Clock: XT
4	0	1969-12-31 17:00:00	0x00000000	EU Clock: XT
5	0	1969-12-31 17:00:00	0x00000000	New IP Address: 169.254.1.1
6	10	1969-12-31 17:00:10	0x00000000	CSP connecting to :4170
7	40	1969-12-31 17:00:40	0x00000000	CSP to :4170 timed out 1 times
8	50	1969-12-31 17:00:50	0x00000000	CSP connecting to :4170
9	80	1969-12-31 17:01:20	0x00000000	CSP to :4170 timed out 2 times
10	90	1969-12-31 17:01:30	0x00000000	CSP connecting to :4170
11	121	1969-12-31 17:02:01	0x00000000	CSP to :4170 timed out 3 times
12	131	1969-12-31 17:02:11	0x00000000	CSP connecting to :4170
13	161	1969-12-31 17:02:41	0x00000000	CSP to :4170 timed out 4 times
14	171	1969-12-31 17:02:51	0x00000000	CSP connecting to :4170
15	201	1969-12-31 17:03:21	0x00000000	CSP to :4170 timed out 5 times
16	212	1969-12-31 17:03:32	0x00000000	CSP connecting to :4170

Figure 7-4: HTML Log

Note that the browser (through javascript in the log page) has added a column with local time based on the Unix time stamp. The Status Word represents the state of the system. Each digit indicates the state of a subsystem. The meaning of the status word is described below, starting from the least significant digit (the rightmost). Add the shown binary weights to yield the logged digit.

- **Connection State**
  - 1 - Connected to DCS
  - 2 - Announce request received
  - 4 - Lease active
- **RPL State**
  - 1 - Fetching RPL
  - 2 - Parsing RPL
- **Timed Text State**
  - 1 - Fetching timed text file
  - 2 - Parsing timed text file
- **Reserved**
- **Captions Ready**
  - 1 - Captions ready for stream 0
  - 2 - Captions ready for stream 1
  - 4 - Captions ready for stream 2
  - 8 - Captions ready for stream 3
- **Caption Transfer**. This digit toggles between 0 and 1 each time a caption is transferred into the transmit buffer.
- **Output Mode Enabled**
  - 1 - The DCS is playing content

Decoding the system state in the first log line, we have 0x00110207. Starting at the right, we decode this as:

- Connected to server, announce request received, lease active
- Not currently fetching or parsing an RPL
- Parsing a timed text file
- Captions ready for stream 0
- Captions have been transferred to the transmit buffer (this digit toggles between 0 and 1)
- The server is not playing content.

Note that you can place the cursor over a status word to see how it is decoded.

Reading the next few lines in the log, we see:

- The DCS sends the **IRC** a timeline update indicating the timeline (frame number) it will start playing and the Playout ID that will play.

- Output mode is enabled (playout starts)
- There are several timeline update messages. These show the DCS time and the ACS (the **IRC** Auxiliary Content Server) times before applying the update. The offset is the user configured offset (on the DCS configuration page). The Delta is the difference between the ACS and DCS times before the update. Once they are synchronized, the delta is usually between -1 and +1.
- There are several TxBuf Loaded messages. These indicate a caption has been moved from the caption FIFO to the transmit buffer and is now being transmitted to the caption receivers. The log line includes the Playout ID, a portion of the movie title from the timed text file, the reel number from the timed text file, the TimeIn for the caption, and a portion of the caption. The stream number is shown in square brackets after TxBuf. the 0 refers to stream 0 or the first language.
- While transmitting captions, the **IRC** continues to fetch and parse RPL and timed text files. In the above log, you can see that it parsed the last caption in Sintel (spot 32) and then recorded that it finished parsing a CineCanvas timed text file. The system can parse both CineCanvas (used in Interop digital cinema packages) and SMPTE timed text files.
- Once the timed text file has been parsed, the **IRC** reports the contents of each buffer, then pulls another timed text record from the RPL buffer. It then fetches the timed text file and parses it.

7.3 CSV Log

The CSV log has the same data as the HTML log. In addition to the Unix timestamp, each row includes an Excel time stamp. Formatting the column for date and time changes this number to a UTC date and time. Figure 7-5 shows the first few lines of the CSV log imported into Excel and with the format of the Excel time column changed to date and time.

Record Nu	Unix Time Sta	Excel Time Stamp	Status Word	Description
3584	1591151462	6/3/20 2:31 AM	0x00110207	ACS edit rate = 24.000000. ACS time = 174115, DCS time = 24, Delta = 174091, ACS offset = 0, PID = 0x55521b43
3585	1591151462	6/3/20 2:31 AM	0x00110207	Changed ACS to match DCS time: ACS time = 174115, DCS time = 24, Delta = 174091, ACS offset = 0, PID = 0x55521b43
3586	1591151462	6/3/20 2:31 AM	0x00110207	UpdateTimelineResponse 0, RRP Success, Captions Ready
3587	1591151462	6/3/20 2:31 AM	0x01110207	Output mode set to enabled
3588	1591151462	6/3/20 2:31 AM	0x01110207	Time looped back but PID changed. Not restarting CSP.
3589	1591151462	6/3/20 2:31 AM	0x01110207	Loaded TxBuf[0], PID=74e1156f, Sintel-E Reel 0, Spot 1, TimeIn=24, (drumbeat)""
3591	1591151463	6/3/20 2:31 AM	0x01010207	TimelineUpdate request received
3592	1591151463	6/3/20 2:31 AM	0x01010207	ACS edit rate = 24.000000. ACS time = 31, DCS time = 51, Delta = -20, ACS offset = 0, PID = 0x74e1156f
3593	1591151463	6/3/20 2:31 AM	0x01010207	UpdateTimelineResponse 0, RRP Success, Captions Ready
3594	1591151464	6/3/20 2:31 AM	0x01010207	TimelineUpdate request received

Figure 7-5: Typical CSV Log

7.4 Telnet to IRC

Clicking this link connects to the **IRC** command interpreter. A connection can also be made to this IP address port 10001 with Putty or Tera Term. Select “Raw” as the protocol. Typing **irc.sys.log|1** followed by a carriage return starts streaming a log to this connection. This log can be captured by Tera Term or Putty. Tera Term allows you to add a time stamp. This is a method of generating a log that is too large to fit in flash memory (or to be reported in the HTML log).

7.5 Config Flash

The ConfigFlash link shows the contents of the configuration flash. Configuration is saved as a series of text commands that are passed through the command interpreter. A portion of a typical ConfigFlash page is shown in Figure 7-6.

```
irc.sys.auditorium      34
irc.sys.comments        The quick brown fox jumped over the lazy dog's back.
irc.sys.dhcp    0
irc.sys.host    HH Captions
irc.sys.dns1    8.8.8.8
irc.sys.dns2    4.4.4.4
irc.sysgateway  10.126.2.1
irc.sys.ip      10.126.2.11
irc.sys.ir_enable       1
irc.sys.mac     0       0       0       0       0       0
irc.sys.mask    255.255.255.0
irc.sys.ntp_ip  time.nist.gov
irc.sys.num_languages   4
irc.sys.dcs_ip  10.108.129.70
irc.sys.theater_name    MIT
irc.sys.theater_number  12
irc.sys.timeline_offset 0
irc.sys.language_priority       0       50      40      49      43      46
irc.sys.language_priority       1       104     103     116     105     106
irc.sys.language_priority       2       56      59      58      57      61
irc.sys.language_priority       3       2       25      26      30      33
irc.sys.rs232_use       0
irc.sys.offline_text_enable_seconds     10
irc.sys.offline_text    0       Moving Image Technologies
irc.sys.offline_text    1       Closed Captioning
irc.sys.offline_text    2       www.movingimagetech.com
irc.sys.livetimeout     10
```

Figure 7-6: Config Flash

7.6 HTTP Buffer

The **IRC** fetches RPL and timed text files. These are put in the HTTP buffer and then parsed. This link allows you to view the contents of the HTTP buffer. It can hold over 400 kB which is plenty for an RPL or a timed text file for a reel. Some DCPs, however, put all the captions in one timed text file instead of breaking it into reels. The **IRC** can handle very large timed text files by fetching them repeatedly and pulling out a 400 kB section to parse. A portion of the HTTP buffer is shown in Figure 7-7.

```
<?xml version="1.0" encoding="UTF-8"?>
<DCSubtitle Version="1.0">
        <SubtitleID>8e03b6e6-7e7e-447f-ac67-ce02705d16e0</SubtitleID>
        <MovieTitle>Sintel-English-ClosedCaptions</MovieTitle>
        <ReelNumber>1</ReelNumber>
        <Language>English</Language>
        <LoadFont Id="arial.ttf" URI="arial.ttf"/>
        <Font Id="arial.ttf" Color="FFFFFF80" Italic="no" Size="44" Weight="normal">
                <Subtitle SpotNumber="86" TimeIn="00:00:00:133" TimeOut="00:00:01:166">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">(weapons clash)</Text>
                </Subtitle>
                <Subtitle SpotNumber="87" TimeIn="00:00:03:166" TimeOut="00:00:07:200">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">(panting)</Text>
                </Subtitle>
                <Subtitle SpotNumber="88" TimeIn="00:00:10:216" TimeOut="00:00:12:016">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">I have failed.</Text>
                </Subtitle>
                <Subtitle SpotNumber="89" TimeIn="00:00:12:233" TimeOut="00:00:14:241">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">Mmm...</Text>
                </Subtitle>
                <Subtitle SpotNumber="90" TimeIn="00:00:17:216" TimeOut="00:00:19:216">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">You've only failed to see.</Text>
                </Subtitle>
                <Subtitle SpotNumber="91" TimeIn="00:00:22:183" TimeOut="00:00:24:008">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">These are dragon lands, Sintel.</Text>
                </Subtitle>
                <Subtitle SpotNumber="92" TimeIn="00:00:25:216" TimeOut="00:00:27:166">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">You are closer than you know.</Text>
                </Subtitle>
                <Subtitle SpotNumber="93" TimeIn="00:00:37:025" TimeOut="00:00:40:125">
                        <Text HAlign="center" VAlign="bottom" VPosition="10">(quiet music playing)</Text>
                </Subtitle>
```

Figure 7-7: HTTP Buffer

7.7 Last RPL URL

The last debug page includes a link to the last RPL received. This link goes to the RPL URL last received from the digital cinema server. The browser will then fetch the RPL from the server. This can be helpful in determining languages and other attributes of the playout. A portion of the RPL display is shown in Figure 7-8.

```
▼<ns2:ResourcePresentationList xmlns:ns2="http://www.smpte-ra.org/schemas/430-Y/2008/resourcePresentationList" PlayoutID="1960908143">
  ▼<ReelResources TimelineOffset="0" ReelID="urn:uuid:d965d7a6-1c79-458c-88de-4aa742b870b0" EditRate="24 1">
    ▼<ReelResource Id="urn:uuid:052767d1-245b-4b33-bbf1-0733a09a8a33" ResourceType="MainSubtitle" Language="ru" EntryPoint="0" Duration="3657" IntrinsicDuration="3657">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource0/subtitle.xml</ResourceFile>
     </ReelResource>
    ▼<ReelResource Id="urn:uuid:7800b57e-7d0f-433f-8293-d8ad43b85268" ResourceType="ClosedCaption" Language="en-us" EntryPoint="0" Duration="3657" IntrinsicDuration="3657">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource1/subtitle.xml</ResourceFile>
     </ReelResource>
   </ReelResources>
  ▼<ReelResources TimelineOffset="3657" ReelID="urn:uuid:4233cf22-2e39-4eee-a08c-8588bf3469fa" EditRate="24 1">
    ▼<ReelResource Id="urn:uuid:07214bfe-5810-4b91-8a05-29191d9a94cc" ResourceType="MainSubtitle" Language="ru" EntryPoint="0" Duration="6775" IntrinsicDuration="6775">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource2/subtitle.xml</ResourceFile>
     </ReelResource>
    ▼<ReelResource Id="urn:uuid:67c50682-4918-459d-993d-b3577d8c22a0" ResourceType="ClosedCaption" Language="en-us" EntryPoint="0" Duration="6775" IntrinsicDuration="6775">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource3/subtitle.xml</ResourceFile>
     </ReelResource>
   </ReelResources>
  ▼<ReelResources TimelineOffset="10432" ReelID="urn:uuid:94077ee2-fb1c-46f3-ac90-1ae7a4b27d3d" EditRate="24 1">
    ▼<ReelResource Id="urn:uuid:d50b83b6-ba15-456b-9773-55561d532757" ResourceType="MainSubtitle" Language="ru" EntryPoint="0" Duration="10879" IntrinsicDuration="10879">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource4/subtitle.xml</ResourceFile>
     </ReelResource>
    ▼<ReelResource Id="urn:uuid:8e03b6e6-7e7e-447f-ac67-ce02705d16e0" ResourceType="ClosedCaption" Language="en-us" EntryPoint="0" Duration="10879" IntrinsicDuration="10879">
       <ResourceFile>http://10.108.129.22/subtitles/auxresources/auxresource5/subtitle.xml</ResourceFile>
     </ReelResource>
   </ReelResources>
```

Figure 7-8: Last RPL URL

8. Troubleshooting

8.1 Testing Server Communications

At times it can be difficult to determine the appropriate server IP address to use. A digital cinema server often has several addresses available on the network and may not support captioning on all those addresses. Further, network routing may interrupt communications between the server and the **IRC**.

An independent way to test the server IP address and routing is to disconnect the **IRC** from the network, then connect a laptop computer that has the same IP address the **IRC** was using. Then, using Putty or Tera Term, make a raw TCP connection to the server IP address on port 4170. The server should accept the connection and send the name of the server along with some “binary garbage.” This is the SMPTE ST 430-10 announce request. If Putty or Tera Term can connect to the server, the **IRC** should be able to. If the connection is refused, ensure the correct IP address is being used, that captioning is enabled on the server, and that the subnet mask, gateway, and other routing configuration is correct.

8.2 LED Indicators

Several LEDs are visible through the bottom grill of the **IRC**. These are shown in Figure 8-1.

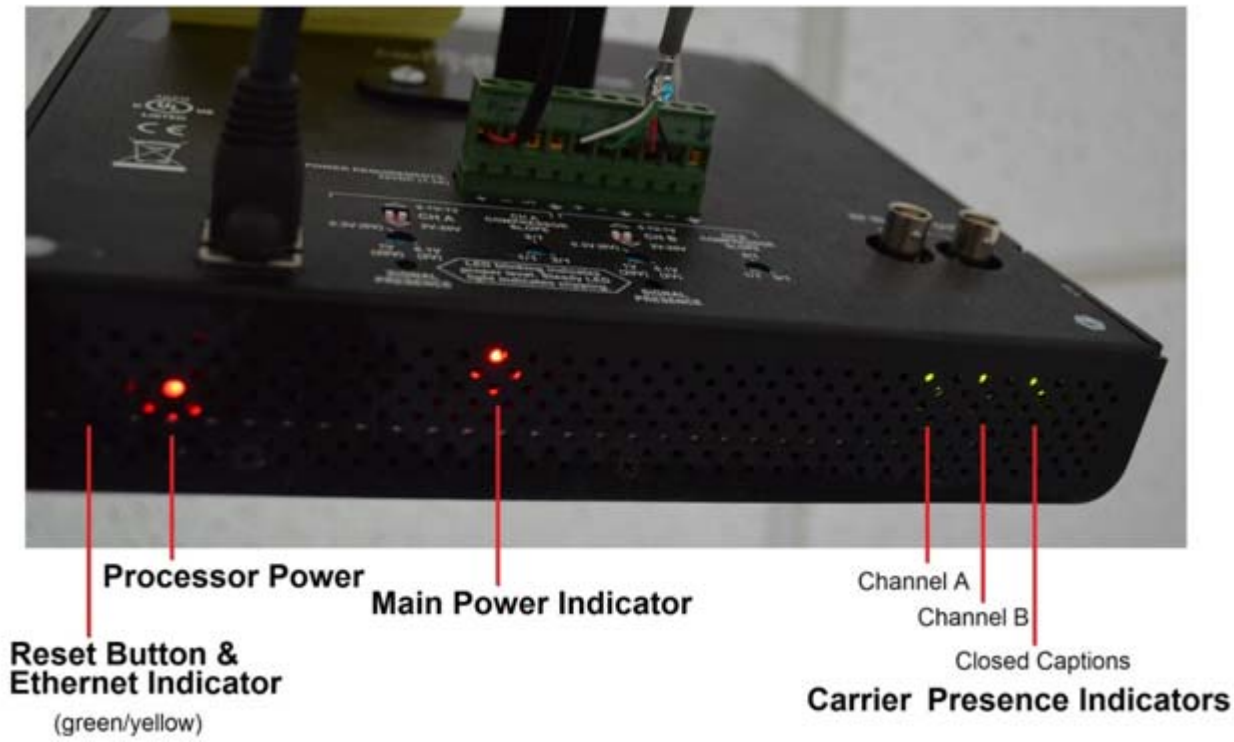


Figure 8-1: IRC LED indicators

These LEDs, especially the carrier presence indicators, can help determine how the system is operating.

NOTE: The image shown in Figure 8-1 is for an **IRC-E** with network card. The Basic **IRC-B** has only the power indicator and the three carrier indicators.

8.3 System Restore

There is a restore button, as shown in Figure 8-1 that can be pressed with a paperclip. The button is beneath the indicated vent hole. There should be an audible click when the button is pressed. See MiT document R000244 for a detailed, step-by-step guide on how to perform a System Restore using this button. The description below is a short summary.

The Restore button has two functions:

- **Set to default IP address** - If the **IRC-E** is already powered up and operating, momentarily pushing the restore button will temporarily restore the IP address to its default (169.254.1.1). This will allow a connection to a unit with an unknown IP address. The desired network configuration can then be set through the configuration pages and that configuration saved. Note that the restore IP address is temporary. It is not stored to flash memory and will not survive a power cycle. The desired IP address must be saved through the web configuration pages. Note also that the Ethernet Discoverer app can also find the IP addresses of devices on the network. The app can be found at http://www.movingimagetech.com/product/irc-28/
- **Restore Factory Firmware** - The factory firmware can be reloaded by removing power from the **IRC**, holding down the restore button, then applying power while holding down the button. The processor power LED will flash as the backup firmware is copied into the microcontroller. When the copy is complete, the **IRC** will reboot with the factory firmware.

9. Firmware Updates

MIT adds features to the **IRC** captioning subsystem on an ongoing basis. Updates are available on the MiT web site product page http://www.movingimagetech.com/product/irc-28/

NOTE: Only the **IRC-E** model has a processor, and thus programming firmware. The Basic **IRC-B** model does not have a processor, therefore no firmware to install or update.

Firmware updates are available as zipped hex files. After unzipping the file, the filename should be similar to IRC-28CvYYMMDD.hex. YYMMDD is the last two digits of the year, the month, and the day of month that the update was generated. From the **IRC** web configuration page, select Firmware Update. Then choose the file to upload to the **IRC** and click the update button. After the firmware has been uploaded, the browser will time out since the **IRC** reboots with the new firmware. Pressing the browser back button to the home page, then reloading the page, should show the new firmware version.

NOTE: If you have updated firmware to the current version but still see old company logos at the top of the web pages, it's because the logo image file is stored in your web browser cache on your PC. If you clear your browser cache and reload the web page, it should then display the current MiT logo.

10. Theory of Operation

10.1 Audio

The **IRC** transmits two channels of Frequency Modulation (FM) audio similar to that used in FM broadcast. The FM signals modulate a bank of IR LEDs.

Incoming audio goes to a differential amplifier, then to a pre-emphasis network that boosts the highs for transmission.

The audio then goes to a dynamic range compressor. A sample of the output voltage drives a voltage controlled amplifier to adjust the gain such that output levels are more uniform. The compression control adjusts how much compression is applied. With 2/1 compression, content with a 60 dB dynamic range is reduced to 30 dB by increasing the level of quieter material.

The output of the compressing amplifier drives a frequency modulated oscillator (FMO) at the desired carrier frequency (2.3 MHz or 2.8 MHz). The FMO passes through an analog switch to the LED driver circuitry. The analog switch disconnects the FMO from the LED driver when there has been no audio for 30 minutes.

The level detector in the audio compressor also drives an analog input on a microcontroller. This microcontroller flashes the signal presence LEDs and controls the analog switch that gates the FMO signal to the LED driver. The analog switch control signal also drives the carrier presence LED visible through the bottom grill of the **IRC**.

10.2 Captions

The **IRC** communicates with the digital cinema server over Ethernet. Here is a brief outline of the typical operation. More detail is available in the **IRC** log.

- The **IRC** connects to the server on port 4170. This connection is visible in the log.
- The digital cinema server accepts the connection and starts sending requests specified by SMPTE ST 430-10.
- The server sends an Announce request. This request identifies the server and sends a time stamp of the current time. The **IRC** responds to the server with its identity and time stamp.
- The server sends a Get New Lease request. This request specifies a timeout after which the **IRC** is to delete all content and wait for another lease request. The lease is renewed with any request from the server. Servers generally send status requests or timeline updates to keep the lease active. The **IRC** responds to the server request.
- The server sends one or more Set RPL Location requests. This request provides the **IRC** with the URL of the Resource Presentation List and a Playout ID that identifies this RPL. The RPL is an XML file as defined in SMPTE ST 430-11. It specifies where in the timeline a particular caption or timed text file will be used, the language of the captions in that file, the URL for that file, and other information. The **IRC** responds with whether it was able to accept the RPL location. The information in the Set RPL Location request is put in a First In First Out (FIFO) buffer in the **IRC**. It is identified as an RPL record in the buffer. This buffer also holds timed text records, discussed later.

- The **IRC** pulls the RPL record from the RPL FIFO. It fetches the RPL from the specified URL. The **IRC** then searches the RPL for languages and assigns each timed text (caption) file in the RPL one or more language streams based on the language priorities set in the **IRC** configuration. The **IRC** then parses the RPL and generates a “timed text record” for each resource file in the RPL. These timed text records are fed back into the RPL FIFO. The timed text records include the URL of the timed text file, the Playout ID of the RPL the record came from, the language streams this file is to drive, and the timeline offset for the captions in the file. Each reel has a timeline offset in editable units or frames. The **IRC** will add this timeline offset to the start and end times in the timed text files to determine when each caption is to appear.
- The **IRC** pulls one or more timed text records from the RPL FIFO. Based on the URL in this record, it fetches and then parses the timed text file. The timeline offset for the file is added to the TimeIn and TimeOut for each caption (and the StartTime in the timed text file is subtracted from the TimeIn and TimeOut in the timed text file). With all this information, the **IRC** forms packets for transmission over IR to the caption receivers. Based on the destination language stream, each packet is placed in one or more caption FIFOs. The timed text files are XML files defined by SMPTE ST 428-7 for use in captions and subtitles. They are further constrained by SMPTE ST 428-10 for use in closed captions.
- The server sends an Update Timeline request. It includes the playout ID that is going to be played along with the timeline (edit unit or frame number) that will be played and the edit unit rate (frame rate). The **IRC** sets an internal edit unit counter and adjusts its speed based on the edit unit rate. The **IRC** responds with a status message.
- The server sends a Set Output Mode request. This request tells the **IRC** that playout has started or it has stopped. If it has started, it starts advancing its internal edit unit clock. If stopped, it stops the clock.
- The **IRC** transmits packets over IR using frequency shift keying. There are two types of packets: time and caption. A time packet tells the receivers the current playout ID, edit unit number, and the edit rate. Caption packets include the language of the caption, the TimeIn and TimeOut (in edit units), The caption packets are pulled from the caption FIFOs at the ending time (TimeOut) of the previous caption. This results in captions being transmitted repeatedly from the TimeOut of the previous caption, through the TimeIn of the current captain, up to the TimeOut of the current caption. The packets include a CRC to detect errors. The packet transmission repetition allows the receivers to recover from packet errors.
- If the server is not playing the content, the **IRC** transmits the user-defined welcome message in caption packets and sets the edit rate in the time packets to zero. Caption receivers recognize the zero edit rate as meaning that either a welcome message or live captions are being transmitted. These are displayed immediately on receipt. When the server is playing content, time packets keep the receivers informed of the current playout ID and timeline position. The caption receivers compare this information with the playout ID, TimeIn, and TimeOut of the caption being received to determine when to display the caption. the receivers also compare the language field in the caption packets with the user selected language in the receiver to display captions for the correct language.

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